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APPENDICES

STATE OF MONTANA
DEPARTMENT OF ADMINISTRATION
COMMUNICATIONS DIVISION

NOVEMBER, 1982

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APPENDIX A

SUMMARY

OF EFFECT OF

DIVESTITURE AND DEREGULATION

OF AT&T

APPENDIX A

SUMMARY OF EFFECT OF DIVESTITURE AND DEREGULATION OF A.T.&T.

ORGANIZATIONAL CHANGES

BEFORE	AFTER
AT&T Corporate Headquarters	AT&T Corporate Headquarters
Western Electric	Western Electric
Bell Laboratories	Bell Laboratories
Long Lines Division	LATA Interexchange/Long Lines
AT&T International	AT&T International
	Embedded Base Organization
	American Bell, Inc.
	Advanced Mobile Phone Service
22 Local System Operating Companies	7 Regional Holding Companies:
	Mid-west Regional Co.
	-Mountain States Telephone & Telegraph
	-Northwestern Bell
	-Pacific Northwest Bell
	Pacific Regional Co.
	-Pacific Telephone
	-Bell of Nevada
	Great Lakes Regional Co
	-Wisconsin Telephone
	-Michigan Bell
	-Indiana Bell
	-Illinois Bell
	-Ohio Bell
	Northeast Regional Co.
	-New York Telephone
	-New England Telephone & Telegraph
	Mid-Atlantic Regional Co
	-New Jersey Bell
	-Bell of Pennsylvania
	-Diamond State Telephone
	-C & P Maryland
	-C & P Virginia
	-C & P District of Columbia
	-C & P West Virginia
	Southeast Regional Co.
	-South Central Bell
	-Southern Bell
	Southwest Regional Co.
	-Southwestern Bell

OTHER MAJOR EFFECTS

AT&T divests itself of the 22 local Bell operating companies.

AT&T and its subsidiary, American Bell, will no longer be regulated except for FCC regulation of long distance transmission service. The local telephone companies will continue to be regulated by State public service commissions.

The local operating companies must share their facilities equally with all long-distance telephone companies and cannot discriminate against AT&T competitors in buying equipment and planning new facilities.

AT&T and its unregulated subsidiary will be permitted to expand into data processing and office automation markets.

Local operating companies will maintain the $3 billion-a-year Yellow Pages businesses.

Local companies can market but not manufacture customer-premised equipment.

AT&T cannot offer any type of electronic news and information retrieval service for at least seven years.

Local Access and Transport Areas (LATAs) will be designated to each local operating company for providing telephone service.

APPENDIX B

STATE OF MONTANA

TELECOMMUNICATIONS

FEASIBILITY ANALYSIS AND NEEDS ASSESSMENT

SEPTEMBER 1981

STATE OF MONTANA

TELECOMMUNICATIONS

FEASIBILITY ANALYSIS and NEEDS ASSESSMENT

September 29, 1981

Prepared by: TELECOMMUNICATIONS INTERNATIONAL, INC.

STATE OF MONTANA

FEASIBILITY ANALYSIS and NEEDS ASSESSMENT

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SECTION I

EXECUTIVE SUMMARY

The State of Montana is a large user of telephone services and equipment. Expenditures in this area will total approximately $3,560,000 in 1981. Increasing pressures from inflation, technical obsolescence and changes in the telecommunications regulatory environment are forcing the State to take a hard look at their current and future utilization of these services and equipments.

Starting in 1979, the State began evaluating alternatives to the existing telephone equipment by comparing Mountain Bell Telephone's new offerings against those of a private telecommunications equipment supplier. As a result of this first evaluation, it was determined that the State's existing equipment was obsolete and would require an upgrade in the immediate future.

In August, 1981, Telecommunications International, Inc. (TII) was retained by the State to more clearly identify any cost and service improvement potentials inherent in the State's telephone system. This report details these potentials as Phase One of a three-phase telecommunications review and improvement project.

For this Feasibility Analysis and Needs Assessment, the four largest users of State telephone equipment were studied: the Helena Capitol Complex, Montana State University, the University of Montana and Eastern Montana College.

At each of these locations, a replacement model for the current telephone system was constructed which would impact current problems or shortcomings presently existing. Based on this model, a ten year cash flow analysis was performed to provide an estimate of replacement costs based on current industry averages.

From both a cost and service viewpoint at all four study locations, it appears favorable to replace the current, obsolete equipment with newer systems. Based on these preliminary indications, TII is recommending that Phase Two of this project be undertaken. Specifically, TII is recommending that competitive bids for replacement telephone systems be solicited utilizing a detailed Request for Quotation to be circulated throughout the telecommunications marketplace.

Once competitive bids are received and evaluated, a final cash flow analysis will be performed utilizing true cost quotations. At this point, the decision will be made whether to proceed into Phase Three (system installation) or not.

SECTION II

INTRODUCTION

The State of Montana will spend approximately $3,560,000 in 1981 for telephone equipment and the Montana State Telephone System (MSTS). Figure One provides a breakdown of these costs as well as a projection of the effect inflation will have on these costs over the next few years. Not included in these annual cost projections are each agency's expenditure for "non-MSTS" long distance calling or Mt. Bell's monthly charge to add, move or change telephone equipment.[1]

As Figure One illustrates, monthly equipment rental charges from Mt. Bell (telephone equipment) accounted for 61.3% of the State's annual expenditure and four distinct entities make up 83.8% of this total. For this reason, this Feasibility Analysis and Needs Assessment will focus on the telephone systems at the Helena Capitol Complex, Montana State University, the University of Montana and Eastern Montana College.

CURRENT SYSTEM DESCRIPTION

All four study locations are currently renting a Centrex telephone system from Mt. Bell. Centrex typically utilizes a large, electromechanical switching device to provide telephone exchange services. Each user is provided an exchange line (main station line) which allows both Direct Inward Dialing (DID) and Direct Outward Dialing (DOD). Internal calling is either four digit or via a manual or dial intercom.

Centrex service is an arrangement which permits completion of inward and outward local and long distance calls from each telephone without intermediate handling by an operator. Long distance calls dialed direct are then identified by station number on the user's monthly bill.

Basic Centrex features include direct inward and Direct Outward Dialing, station-to-station calling, station hunting, call transfer-attendant, power failure transfer, night service and identified dialing.

The Direct Inward Dialing (DID) feature provides that local and long distance calls to the associated station number will be completed without intermediate handling by an attendant. One primary directory listing in the main directory of the serving central office is provided for each Centrex system. An additional listing of each DID number is provided at a nominal charge.

Identified outward dialing (IOD) feature provides that outgoing long distance calls will be operator identified by station number and that such calls will be listed on the user's monthly bill.

The type and quantity of equipment and services used in providing Centrex are determined by the telephone company (Mt. Bell). The switching equipment may be installed on the user's premises, or at the option of the telephone company, on their premises.

[1] The cost for adds, moves and changes for the Helena Capitol Complex was $73,121 in 1980 and "non-MSTS" long distance calls amounted to $154,296.

STATE OF MONTANA

1981 TELEPHONE EXPENDITURE

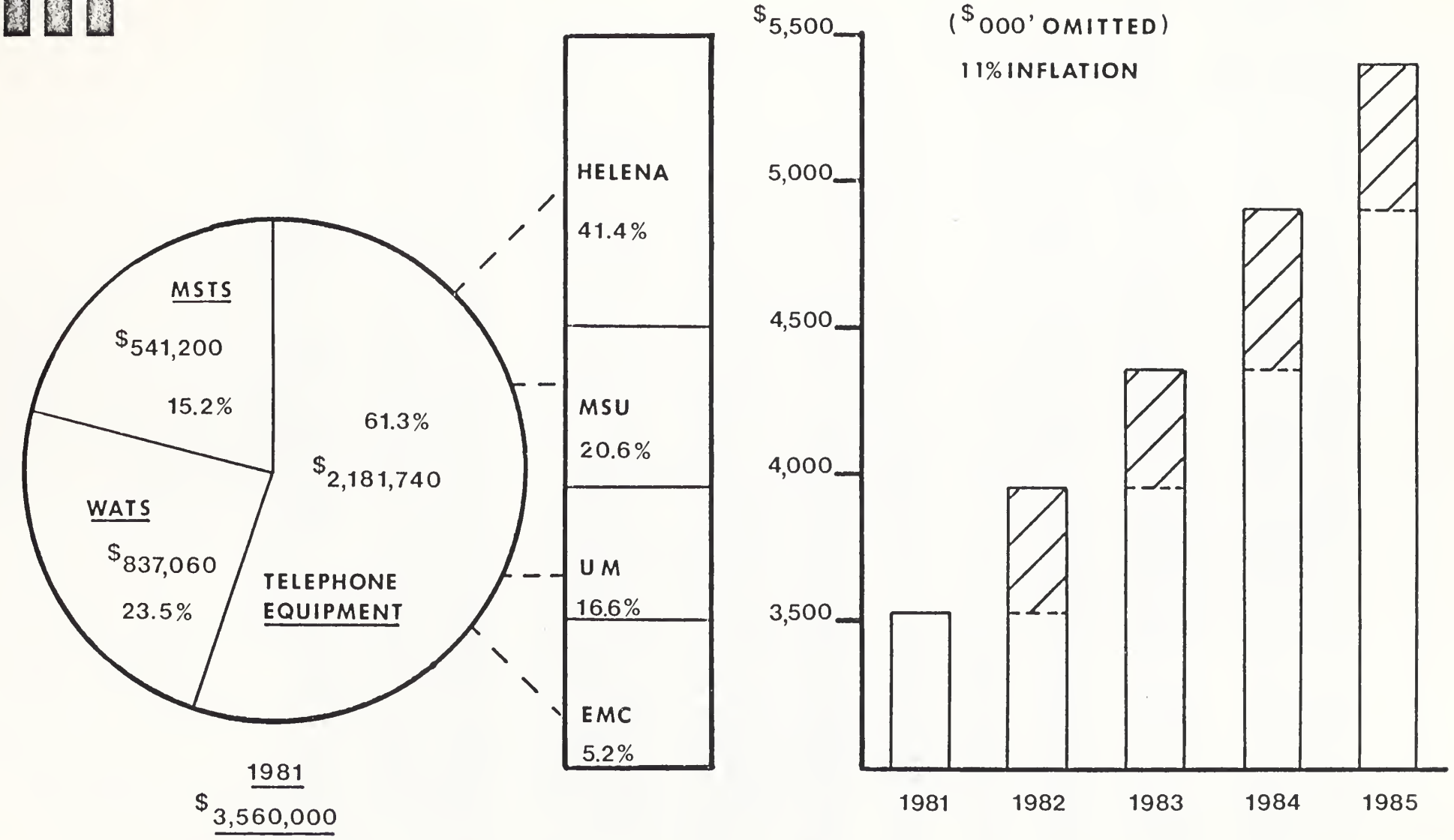


FIGURE 1.

Centrex's original popularity was due to the fact that each main station line could be assigned a unique directory number allowing callers direct access to that extension without assistance from an attendant (console operator). For large systems, this capability was a must. Centrex service also allowed Mt. Bell to bill each extension for it's long distance charges, facilitating customer administration of the system.

For a customer with several locations (a university for example) Centrex also allowed the provision of telephone service to multiple sites, with a monthly charge for mileage applied to circuits serving remote locations.

The State of Montana's telephone system consists of nineteen of these Centrex systems located throughout the State, serving approximately 8,700 main station lines and consisting of 10,200 telephone instruments.

As mentioned earlier, this study concentrates on the four largest State administered systems.

Figure Two illustrates the equipment configuration at the four study locations and also shows the components of the MSTS network.

The Centrex switch for the Helena Capitol Complex (HCC) acts as the hub for all MSTS traffic by switching tie-lines and providing dial access to WATS facilities.

Therefore, each site is provided it's own Central Office (C.O.) trunks for local incoming and outgoing calls. Incoming long distance calls (non-MSTS) also utilize these C.O. trunks as do certain outgoing long distance calls (collect, credit card, third number billing, etc.). Tielines to Helena provide MSTS and WATS access.

Each of the four locations also provide service to other State agencies located either off-campus or in the case of Helena, outside the Capitol Complex. These extensions are labeled "off premise extensions" (OPX) and appear as normal Centrex stations except Mt. Bell attaches a distance sensitive "mileage charge" to each of these circuits.

Centrex utilizes both single-line telephone instruments (no buttons for hold or multiple line access) and industry standard (1-A2) key telephone systems which allow access to several lines to many telephones equipped with hold buttons and line access buttons. All four study locations use both types of instruments. See Sections III and IV for an itemization of each study location's equipment.

The major purpose of this study is to evaluate the suitability of continuing to provide telephone service at these four locations via Centrex service. There are three areas of consideration regarding current problems or shortcomings inherent with Centrex: 1) financial, 2) technical, 3) regulatory.

STATE OF MONTANA

STUDY LOCATIONS EQUIPMENT

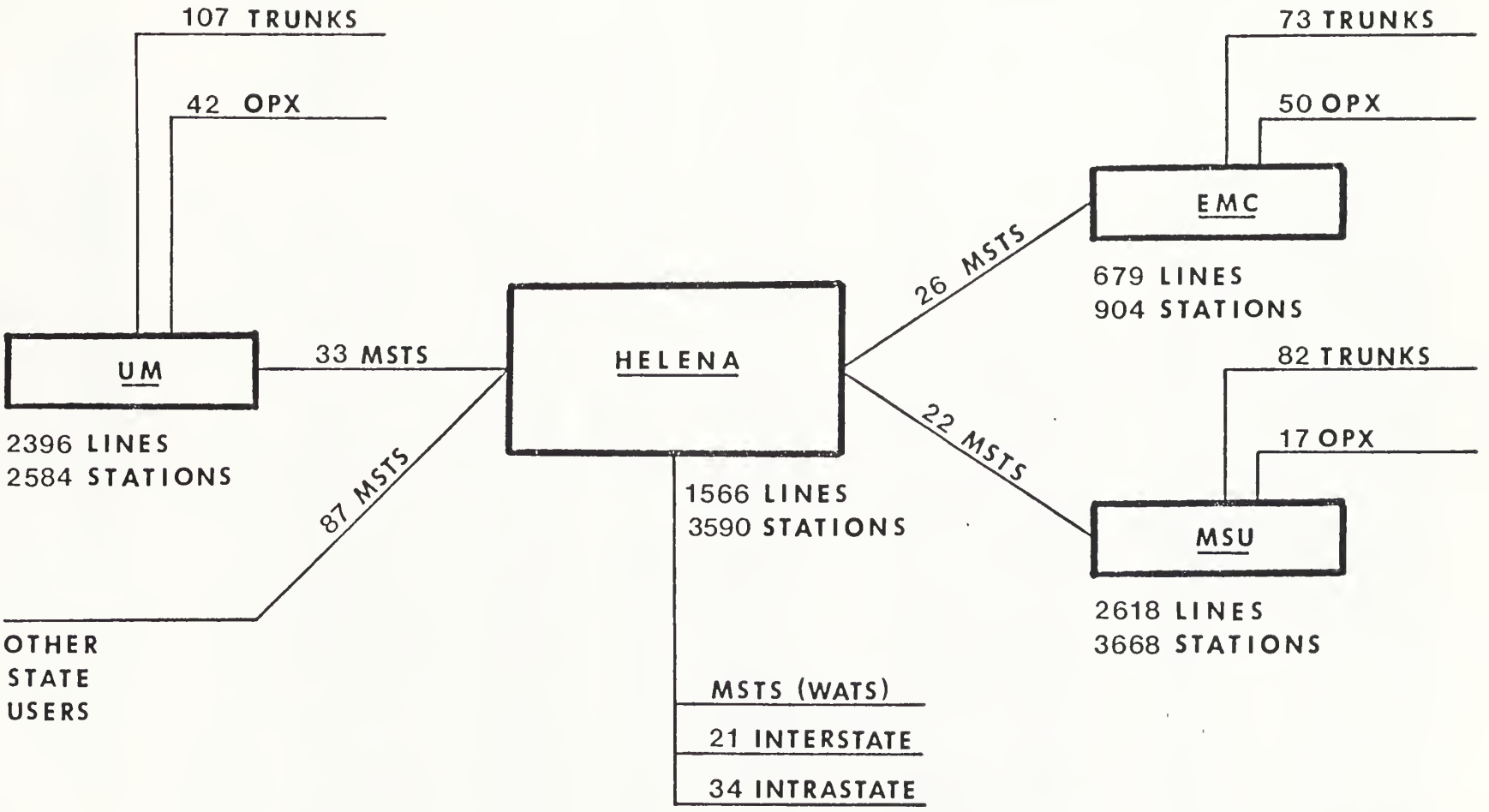


FIGURE 2.

Centrex is considered an "obsolete" offering from a regulatory viewpoint. This means that Centrex will not be furnished as a new service to any customer or applicant. Additional equipment (station lines, attendant positions and optional service features) will be added to existing systems only so long as the existing switching equipment is capable of providing the requested service and the required equipment is available from existing or recovered stock.[1]

Basically, the telephone company is phasing out the use of these out-dated electromechanical switching devices that most Centrex systems are based on. These switches are becoming more expensive to maintain and additional equipment is becoming scarce.

Since the 1960's electromechanical switching equipment (Centrex) has been steadily replaced with systems utilizing some form of stored program control (computer). Modern, fully electronic switching systems like the Western Electric Dimension private branch exchange (PBX) offered by the Bell System, are highly compact, consume much less power, are much quicker and require considerably less maintenance than the Stowger step by step switch (Centrex 701) developed in 1932, or the crossbar system frequently used for Centrex switching. Therefore, Mt. Bell would like to gradually replace this equipment with modern switches which are less costly to maintain.

This situation is demonstrated by the increasing costs for Centrex. For example, the Centrex rental charge for Helena (labeled "service and equipment") has risen from $359,657 in 1975 to $738,100 in 1980. A recent rate increase which will go into effect in mid-October, raises Centrex access charges by 40%.

This well established trend of rising Centrex costs is not only a result of the technical obsolescence of Centrex but is also a result of Bell's preparation for the pending deregulation of the telephone industry.

In 1980, the Federal Communications Commission (FCC) ruled that effective March 1982, AT&T must sell or lease terminal equipment through an arm's-length subsidiary which would compete equally with companies outside the Bell System (AT&T's basic network service will continue to be regulated).[2]

To prepare for this competiton, Bell has begun a strategy to prematurely retire equipment that may be vulnerable to competition once the telephone equipment market is deregulated. Termed the "migration strategy", Bell plans to migrate or move-up customers to the latest generation equipment (e.g. Dimension) by continually raising the costs for obsolete equipment (Centrex).

[1] Mountain States Telephone and Telegraph Company
Montana - General Exchange Tariff
Section 6 Part 5

[2] Wall Street Journal, April 24, 1981.

Although Bell states that "this strategy facilitates the replacement of obsolete equipment with newer systems that are less costly to maintain ... and that the repricing of old equipment would be necessary whether or not the company had a migration strategy ... since Bell has equipment that is renting at one-third the cost to maintain it, "the strategy is clear."[1]

Bell's timetable calls for replacing most of its' electromechanical switches by 1983. In their place, it hopes to substitute the Dimension, along with a resulting four year contract that the older systems didn't have. Bell now proposes to achieve this migration through the coercive route of regular price increases on older equipment. Hence, the recent substantial cost increases for the State's Centrex systems.

The last drawback to Centrex service is technical. The newer switching devices have a variety of features and capabilities unavailable with Centrex that can save time and money.

For example, in a recent Mt. Bell proposal to the State for a Dimension, the following features were offered:

System Features

Automatic Route Selection
CCSA Access
Direct Inward Dialing (DID)
Loudspeaker Paging - Deluxe
Miscellaneous Trunk Restriction
Remote Access to PBX Services
- With Voice Switched Gain
- Via Authorization Codes
Station Message Detail Recording (SMDR)
Tandem Tie Trunk Switching
Tie Trunk Access
Toll Restriction - 0/1

Station Features

Automatic Callback-Calling
Call Forwarding
- All Calls
- By & DA
Call Hold
Call Pickup
Call Waiting Services
- Originating Call Waiting
- Terminating Call Waiting
Controlled Outward Restriction
Controlled Termination Restriction
Data Privacy
Data Restriction
Executive Override
Fully Restricted Stations
Inward Restriction
Manual Terminating Line Service
Night Station Service-Full Service
Origination Restriction
Outgoing Trunk Queueing
Threeway Conference Transfer
Trunk Answer From Any Station

Attendant Features

Alphanumeric Display for Attendant Position
Attendant Conference
Attendant Control of Trunk Group Access
Attendant DSS With Busy Lamp Field
Direct Trunk Group Selection
Incoming Call Identification
- Alphanumeric Display
Interposition Calling
Interposition Transfer
Privacy & Lockout
Timed Recall on Outgoing Calls

[1] Wall Street Journal, April 24, 1981.

Although it's not necessary to define all of these features at this time, an explanation of a few of them will serve to demonstrate the advanced capabilities of these new switching devices.

The following definitions are from the Master Glossary of Terminology, The Marketing Programs and Services Group, Inc., Gaithersburg, Maryland, Copyright 1981.

Automatic Route Selection

"Usually found only in processor-controlled systems, this facility gives to the switching system (via varying degrees of sophistication) the responsibility to select the most economical circuit to use on outgoing calls initiated by stations. Most frequently, this involves switching system analysis of the first three or six digits dialed by the station user and making its route selection based on 'look up' tables contained in the switching system memory. In some systems, the station user is required to dial a special prefix code before any outgoing call will receive such treatment. In most systems, the individual Class Marking of originating stations will determine to what degree that particular user may 'advance' through this analysis to the eventual point of being allowed to originate a toll call over the public exchange network."

This capability would simplify dialing for MSTS users and could significantly lower long distance costs.

Station Message Detail Recording

"Provides a record of the calling station or attendant number, starting time, call duration, all digits of the called number and the specific trunk or trunk group used for outgoing calls. Different manufacturers take various approaches to providing this total service, and may or may not include a terminal device for printouts or a processing service to manipulate the recorded date in order to produce a variety of management reports and summaries. In almost all cases, this data is accumulated on magnetic tape or a similar storage medium; however, a few systems bypass any storage steps and provide a line printer for a written record of outgoing calls as they occur. Usually, only completed calls are so recorded, but some systems provide the optional capability of recording calls which terminate in busy signal or don't answer."

This capability is curently provided to a limited extent by the Telesciences accounting system for the MSTS. However, unlike the Telesciences device, SMDR is a built-in capability and much more sophisticated.

Automatic Callback

"Frequently associated with the Station Camp-On feature, this facility is not necessarily restricted to that association. Also, this feature is normally provided with a time-out condition which completely cancels the feature after a predetermined time period. Some systems provide this facility to all stations within the system, while others provide it to stations which are specifically class marked for such capability. When a station initiates a call to another station which is busy, this feature is activated at the calling station by dialing a single digit or depressing an instrument Feature Button upon receipt of busy signal. After the calling station has activated the feature he merely hangs up. While in activation,

this feature does not prevent the calling station from either initiating or receiving other calls. When both parties (calling and called) become free, the system automatically rings and connects both parties. In more sophisticated systems, the calling party is first rung, and when that station goes offhook, then the called station is rung. Slight variations to this basic facility include providing a distinctive warning tone to the called party when this feature is activated by another internal caller."

In conclusion, the current Centrex systems are no longer capable of providing the enhanced capabilities necessary to meet the State's telecommunications needs in a cost-effective manner.

PROJECT DESCRIPTION

The goal of this Telecommunications Feasibility Analysis and Needs Assessment is to evaluate the continuation of Centrex service in light of current technologies, the regulatory environment and financial considerations.

The State acknowledged user dissatisfaction with the current system in 1979 by issuing a Request For Proposal (RFP) for a "solid state electronic telephone system". Although at that tme, only Mountain Bell and Rolm Intermountain responded, their proposals did reflect the advantages of an electronic private branch exchange (PBX) versus the current Centrex systems.[1]

Another telecommunications needs assessment was performed by a Telephony Task Force under State direction and submitted during April, 1981. This analysis of the States' systems even further defined the problems inherent in the current systems and recommended that Centrex be replaced with newer equipment for both technical and financial reasons.

The current project will serve to solidify these conclusions by performing a projected cash flow analysis comparing current system costs against estimates for PBX system costs for each of the four study locations. The conclusions regarding the technical obsolesence of Centrex are foregone at this point.

Therefore, the financial efficiency in replacing these Centrex systems will become the primary determining factor.

Based on both current and future needs, Telecommunications International, Inc. (TII) has constructed a model embodying equipment and capabilities requirements for each study location. This model is then priced utilizing current industry averages and then compared against existing system costs at each location.

In all four cases, a PBX (or several PBX's in the case of Helena) is compared against the existing Centrex system.

Telephone costs must be considered, and evaluated, as an on-going expense. Trunking, Direct Inward Dialing (DID), touchtone and maintenance costs continue from year to year. For this reason, the most accurate method to compare the true costs of different systems is to perform a projected cash flow analysis, which allows the difference in maintenance costs and financing options to become more apparent.

[1] Reference Review of Telecommunications Proposals September, 1980, prepared by Consulting Services Bureau, Information System Division, Dept. of Administration.

Therefore, when comparing the existing Centrex system's costs to a PBX estimate, a ten year cash flow projection is performed utilizing the following assumptions:

Inflation - All on-going system costs (trunking, DID, touchtone, maintenance) were inflated by 11%, compounded annually. For Mountain Bell, the monthly equipment rental for the existing Centrex systems was also inflated by 11%, compounded annually, after the 40% increase for Centrex access (just granted) was added.

Private Systems - The costs shown for the private systems include full maintenance contracts, beginning in the second year and inflated by 11%, annually.

Common Charges - For all projections, the yearly costs for central office trunking, Direct Inward Dialing (DID) and touchtone are included and inflated by 11%, compounded annually. A 10% trunk to station ratio was utilized to approximate the existing grade of service. A breakdown of these quantities and costs is provided for each system.

Cost of Money - For the PBX estimate, a seven year lease/purchase ($1 buyout at expiration of lease) was used with an effective interest rate of 11 3/4%.

Discount Rate - To demonstrate costs in terms of net present value, an 11% value of money was utilized to discount each projection.

This, then, will form the basis for TII's recommendation at the conclusion of this project.

The State of Montana must bear in mind the fact that interconnect (private) telecommunications firms now account for an estimated 14% of the U.S. installed base of PBX equipment. Table One provides the 1981 projected U.S. market shares of PBX shipments. Predictions are that interconnect shipments will increase by 9% annually through 1985 while AT&T's shipments will increase by a lower 4% during the same period. Between now and 1983, an estimated 20% of all businesses will be looking for replacement PBX's, partly due to obsolesence and partly to the migration strategy.

TABLE ONE
1981 PROJECTED PBX U.S. MARKET SHARES[1]

SUPPLIER	PERCENT
AT&T (Western Electric)	56%
Northern Telecom	10
Rolm Corp.	9
GTE Automatic Electric	7
Digital Telephone (Harris Corp.)	7
Other Interconnect Co.'s	6
Mitel, Inc.	5
	100%

In either case, most large telephony users are actively evaluating alternatives to their traditional systems and the State of Montana should be no different.

Therefore, this report addresses the cost and service improvement potentials available to the State by evaluating alternatives and recommends a blueprint for action to accomplish these improvements.

[1] Eastern Management Group, Industry Week, August 24, 1981.

SECTION III

UNIVERSITY SYSTEMS

As each University is a unique entity with different operating environments and equipment requirements, they will be addressed separately in this Section. At the end of each separate University section, there is also a discussion concerning dormitory service and a summary of University considerations relevant to all systems.

EASTERN MONTANA COLLEGE

EQUIPMENT & COST PROFILE

Eastern Montana College (EMC) is currently provided telephone service via a Mt. Bell Centrex system. This consists of an electromechanical switching device (701B) located on University property. Table Two provides a listing of this systems' equipment.

TABLE TWO
EMC TELEPHONE EQUIPMENT

DESCRIPTION	QUANTITY
701 B Centrex System	1
Main Station Lines[1]	679
-administrative	-213
-dormitory	-466
Telephone Instruments[1]	904
-single-line	-605
-multi-line	-299
Off Premise Station Lines	50
Network Tieline Terminations	26
Central Office Trunks	73

This Centrex system provides direct telephone service to both the administration and dormitory residents of EMC as well as fifty (50) lines to other State agencies located in Billings. In addition, this system provides access to the MSTS network to EMC administrators, other Billings' State agencies and to 624 North 24th and 1237 North 29th via two (2) tielines. Students are denied access to the MSTS.

EMC's annual expenditure for telephone services and equipment is approximately $162,852 (see Figure One) and is distributed in Table Three.

[1] Based on survey conducted by TII September, 1981

TABLE THREE
EMC TELEPHONE COSTS

DESCRIPTION	MONTHLY COST	PERCENTAGE
Centrex Equipment Rental	$9,454.00[1]	69.7%
Other Charges & Credits	286.00[2]	2.1
Long Distance	775.00[3]	5.7
Intrastate Network	1318.00	9.7
Interstate Network	1738.00	12.8
TOTAL	$13,571.00	100.0%

As discussed in Section II, EMC accounts for 5.2% of the States' telephone equipment expenditure ($113,448. annually).

As Table Three illustrates, the Centrex equipment rental charge (S&E) from Mt. Bell constitutes the major portion (69.7%) of EMC's telephone expenditure. This same expenditure category is also the hardest hit by inflation in the form of telephone company rate increases. For example, the S&E portion of EMC's monthly bill was $8,303. for April, 1979. Two years later, EMC's S&E charge had increased 13.7% to $9,442. As of July, 1981, the monthly Centrex cost was $9,731. representing an increase of 8.6% in a one year period

CURRENT PROBLEMS

EMC's major problem with the Centrex system is increasing rental charges from Mt. Bell for Centrex service and equipment. A recently approved rate increase (40% increase on access charges) will increase EMC's service and equipment bill from $9,731. to approximately $11,648. per month. This increase should become effective by mid-October according to the Montana Public Utilities Commisssion.

[1]Based on Mt. Bell billing for period of September 1980 thru June 1981.

[2]Based on Mt. Bell billing for period of July 1980 thru July 1981.

[3]This is the cost for "non-network" long distance calls such as collect or credit card calls. Based on average for same period as Note 2.

Mr. Kenneth W. Heikes (Administrative Vice President) expressed the following concerns during an interview with TII and State of Montana personnel ...

- o The present system is providing a poor grade of service (G.O.S.) resulting in a frequent "system busy" condition and requiring more incoming and outgoing lines;
- o EMC would like to have their present system updated, providing new features and incorporating new technology;
- o Call forwarding would allow EMC to reduce secretaries during summer months, saving EMC money;
- o During the period of 3-5 p.m., it's difficult to obtain outside lines;
- o Continuing to provide service to residence halls is a large concern;
- o Touchtone would save time and EMC is interested in improving on-campus data transmission capabilities in the future;
- o EMC experiences a 3 to 4 week delay in Mt. Bell's response to service requests;
- o EMC would like a station message detail recording system (SMDR).

PROPOSED SYSTEM DESIGN

EMC's current ratio of main station lines to telephone sets is 679 (lines) to 904 (sets). Utilizing key telephone systems, approximately 225 instruments share a main station line(s).

When replacing a Centrex system with a modern PBX, multi-line telephones (key systems) are often exchanged for single-line telephones which, through utilizing enhanced PBX features, allow coverage of other extensions, call transfer capabilities, hold, etc. However, experience has shown that it's unrealistic to eliminate all multi-line telephones. Therefore, depending on the final system installed, the mix of single-line and multi-line sets can vary considerably.

For purposes of this analysis, TII constructed a replacement PBX model consisting of 830 main station lines versus the existing 663 Centrex main lines and 910 telephone sets identical to the current system. The model PBX would utilize 760 single-line telephones and 150 multi-line telephones, either electronic sets or standard (1-A2 type) key equipment. Table Four lists the components of this replacement PBX model.

TABLE FOUR
EMC REPLACEMENT PBX MODEL

ITEM	QUANTITY	COST
Electronic PBX	830 Main Stations	$664,000.00
Distribution Plant	Complete Changeout	$140,460.00
Telephone Sets	760 Single-line 150 Multi-line	Included
Trunking		
- direct in dial	42	$1,200.00 monthly $546.00 install
- direct out dial	58	$1,860.00 monthly $754.00 install
- direct in dialing - service	700 no's	$934.00 monthly $2,240.00 install
Maintenance	begins in 2nd yr.	$1,820.00 monthly

Based on this model, Table Five projects these PBX costs utilizing the cash flow assumptions described in Section II. These costs are compared against the existing Centrex system cost only to provide a form of benchmark and to allow EMC to observe the difference between renting and purchasing a telephone system.

However, making a financial comparison of Centrex to a PBX estimate, is unrealistic for a variety of reasons. First, it is highly doubtful that Mt. Bell would allow the continuation of Centrex for an additional ten year period. With deregulation pending and Bell's migration strategy in full swing a ten year Centrex projection is only useful as a financial benchmark. From a cost point of view, Table Five appears to show an insignificant long-term savings over the PBX model. This table also indicates a higher up-front cost for the PBX for the first seven years. In actuality, there are many "soft dollar savings" available with a PBX that are not included in this projection, such as reduced administration costs (adds, moves and changes) and reduced long distance calling costs. In addition, the other State agencies served by this system will contribute towards paying these costs. Lastly, by utilizing the variety of financing options available to a tax-exempt State agency, the initial, higher, up-front costs could be easily smoothed out over the ten year life of this projection. In conclusion, Table Five is a preliminary comparison of estimated costs for a PBX only and after bids are received true costs will be utilized to perform similar projections and thereby provide EMC with a more realistic cash flow projection.

TABLE FIVE
PBX MODEL VERSUS CENTREX COST PROJECTION
$000's omitted

	CENTREX		PBX MODEL	
YEAR	ACTUAL	PRESENT VALUE	ACTUAL	PRESENT VALUE
1982	$139.8	$125.9	$220.5	$199.0
1983	155.2	125.9	244.1	198.1
1984	172.2	125.9	252.4	184.6
1985	191.2	125.9	261.5	172.3
1986	212.2	125.9	271.8	161.3
1987	235.2	125.9	283.1	151.4
1988	261.4	125.9	295.5	142.3
1989	290.2	125.9	140.3	60.9
1990	322.1	125.9	155.8	60.9
1991	357.6	125.9	172.9	60.9
TOTAL	$2,337.4	$1,259.1	$2,297.9	$1,391.7

Although the net long term financial difference between the PBX model and EMC's existing Centrex system is not substantial, there would be other cost-savings available from replacing the Centrex system. As mentioned by Mr. Heikes, reducing secretaries during the summer would save EMC money. Utilizing an automatic route selection (ARS) feature would reduce EMC's long distance bill and the cost for additions, moves and changes in equipment could be reduced by 30% conservatively.

TII is recommending that EMC solicit competitive bids for a modern PBX to replace their Centrex system. Once actual bids are received, another cash flow projection can be performed utilizing actual costs for a variety of systems.

Tabel Six sets an estimated timetable for this process.

TABLE SIX
EMC REPLACEMENT TIMETABLE

ITEM	MONTH
Final System Design	1
Request For Quotation	1
Bids Received	4
Evaluation/Recommendation	6
Award	8
Installation	11
Testing	12
Cutover	13
Acceptance	13
	13 Total Months

MONTANA STATE UNIVERSITY

EQUIPMENT & COST PROFILE

Montana State University (MSU) utilizes a CO Centrex system based on a 701B, step-by-step switching device. Table Seven provides an inventory of MSU's Centrex equipment and Table Eight provides a cost profile of MSU's total annual telecommunications expenditure.

TABLE SEVEN
MSU TELEPHONE EQUIPMENT

DESCRIPTION	QUANTITY
701B Centrex System	1
Main Station Lines[1]	2618
- administration	-697
- dormitory	-1921
Telephone Instruments[1]	3668
Off Premise Station Lines	17
Network Tieline Terminations	22
Cenrtral Office Trunks	82

TABLE EIGHT
MSU TELEPHONE COSTS

DESCRIPTION	MONTHLY COST (Average)	PERCENTAGE
Centrex Equipment Rental[2]	$37,453.	63.5%
Other Charges & Credits[3]	1,933.	3.3
Long Distance[4]	7,064.	12.0
Intrastate Network[5]	12,516.	21.2
Interstate Network[5]	12,516.	21.2
TOTAL	$58,966.	100.%

As we discussed in Section II, MSU accounts for 20.6% of the States' telephone equipment expenditure ($449,436. annually) and this Centrex rental charge accounts for 63.5% of MSU's total costs.

Although the equipment rental is shown as $37,453., this is an average for the period of December, 1980 thru March, 1981. As of May, 1981, this monthly cost had increased to $37,793.

[1]Based on Mt. Bell service and equipment billing record for April, 1981

[2]Based on Mt. Bell billing for period of Dec. 1980 thru March 1981

[3]Based on ten month average for period of June 1980 thru May 1981, excluding dormitory credits

[4]Based on twelve month average for period of June 1980 thru May 1981

[5]Based on twelve month average for period of August 1980 thru July 1981

CURRENT PROBLEMS

As with all other State Centrex systems, the major problem is escalating equipment costs. Although an increase of approximately 9% was demonstrated for the period of June, 1980 thru May, 1981, the recently approved rate increase will further escalate MSU's monthly equipment rental from $37,793. to approximately $45,253. This should become effective by mid-October.

Aside from this obvious problem, the following are additional difficulties inherent in the current Centrex system at MSU:

- The Telescience toll accounting device has been at capacity for over a year, disallowing additional MSTS access lines.

- The present sytem is providing a low grade of service (G.O.S.) resulting in frequent "system busy" conditions especially on WATS lines. During heavy usage periods, the MSTS functions poorly, dropping or losing calls.

- MSU would like to replace their current stand-alone intercom system which apparently doesn't work well.

- An automated billing system (SMDR) would allow billing by account for WATS usage.

- Enhanced features such as hunting, transfer and conferencing could facilitate operation.

PROPOSED SYSTEM DESIGN

MSU's current ratio of main station lines to telephone sets is 2618 (lines) to 3668 (sets). This is the result of using key telephone equipment that allows many sets to share few lines. However, many multi-line sets used in key systems can be changed to single-line sets when utilizing the enhanced features of an electronic PBX. When this is done, however, a main station line is required for each telephone set.

Therefore, when configuring a PBX to replace a Centrex system (typically heavy in multi-line sets) main lines are increased in a direct relation to reduction in multi-line sets.

For purposes of this analysis, TII constructed a PBX model consisting of 3100 main station lines versus the existing 2618 Centrex main lines and 3600 telephone instruments identical to the current system. The model PBX would utilize 3100 single-line instruments and 500 multi-line instruments, either electronic sets or standard (1-A2 type) key equipment. Table Nine lists the various components of this replacement PBX model.

TABLE NINE
MSU REPLACEMENT PBX MODEL

ITEM	QUANTITY	COST
Electronic PBX	3100 main stations	$2,480,000.
Distribution Plant	complete changeout	$539,505.
Telephone Sets	3100 single-line 500 multi-line	included
Trunking		
- direct in dial	87	$2,486. monthly $1,131. install
- direct out dial	113	$3,625. monthly $1,469. install
- Direct in dialing service	2500 no's.	$1,854. monthly $8,000. install
Maintenance	begins in 2nd year	$7,200. monthly

Based on this model, Table Ten projects these costs utilizing the assumptions described in Section II. To provide some form of benchmark against which to compare these costs, a projection of the current Centrex system cost is provided, based on the May 1981 Mt. Bell billing for service and equipment ($37,793.) adjusted to reflect the recent rate increase to become effective by mid-October ($45,253.) However, comparing the PBX model to the existing Centrex system is unrealistic for several reasons. First of all it is doubtful that Mt. Bell will offer this type of Centrex for another ten years. The obsolete nature of the equipment coupled with the pending deregulation of the telephone industry will eventually force the discontinuation of this offering. Secondly, the PBX model is significantly different than the Centrex system. The PBX is equipped with approximately 500 more main station lines than the Centrex system in addition to the advanced capabilities inherent in a modern PBX. The financial comparison of these two systems is only presented to demonstrate the differences between renting and purchasing a system and to provide an estimate for a PBX replacement.

TABLE TEN
PBX MODEL VERSUS CENTREX COST PROJECTION
$000's omitted

	CENTREX		PBX MODEL	
YEAR	ACTUAL	PRESENT VALUE	ACTUAL	PRESENT VALUE
1982	$543.0	$489.2	$741.0	$668.6
1983	602.8	489.2	827.3	671.5
1984	669.1	489.2	848.5	620.4
1985	742.7	489.2	872.0	574.4
1986	824.4	489.2	898.1	533.0
1987	915.0	489.2	927.1	495.7
1988	1,015.7	489.2	959.2	462.0
1989	1,127.4	489.2	360.0	156.2
1990	1,251.4	489.2	399.7	156.3
1991	1,389.1	489.2	443.6	156.2
TOTAL	$9,080.6	$4,892.0	$7,276.5	$4,494.3

As Table Ten demonstrates, a long term savings is indicated due primarily to the purchase of the system. Note the dramatic reduction in cost for the PBX model in 1989 due to the termination of the lease.

There would be other cost savings resulting from the replacement of the Centrex system. For example, utilizing the automatic route selection (ARS) capability, MSU's toll bill could be reduced. The cost for other charges and credits (OCC's) has historically been reduced by at least 30% when upgrading a Centrex system to a PBX. Lastly, savings in labor costs would result from reducing secretaries during summer months and from reducing time spent on the telephone.

Therefore, from a financial viewpoint, replacing the Centrex system at MSU with a modern PBX appears favorable. TII is rcommending that competitive bids be solicited for a replacement system based on the PBX model. Table Eleven projects an estimated timetable for such a process.

TABLE ELEVEN
MSU REPLACEMENT TIMETABLE

ITEM	MONTH
Final System Design	1
Request For Quotation	1
Bids Received	4
Evaluation/Recommendation	6
Award	8
Installation	12
Testing	14
Cutover	15
Acceptance	17
	17 Total Months

UNIVERSITY OF MONTANA

EQUIPMENT & COST PROFILE

Telephone service is provided at the University of Montana (UM) via a Mt. Bell Centrex system utilizing a NEC 23 electromechanical switching vehicle, located on University property. Table Twelve details the configuration of this system.

TABLE TWELVE
UM TELEPHONE EQUIPMENT

DESCRIPTION	QUANTITY
NEC 23 Centrex System	1
Main Station Lines[1]	2396
- administrative	-1055
- dormitory	-1341
Telephone Instruments[1]	2584
- single-line	-1982
- multi-line	-602
Off Premise Station Lines	42
Network Tieline Terminations	33
Central Office Trunks	107

UM's annual expenditure for telephone services and equipment is approximately $561,984 (see Figure One) and is distributed in Table Thirteen.

TABLE THIRTEEN
UM TELEPHONE COSTS

DESCRIPTION	MONTHLY COST (Average)	PERCENTAGE
Centrex Equipment Rental[1]	$30,180.	64.4%
Other Charges & Credits[2]	1,201.	2.6
Long Distance[1]	4,371.	9.3
Intrastate Network[1]	3,930.	8.4
Interstate Network[1]	7,150.	15.3
TOTAL	$46,832.	100.%

As discussed in Section II, UM accounts for 16.6% of the States' telephone equipment expenditure ($362,160 annually).

[1]Based on Mt. Bell service and equipment billing for the period of December 1980 thru June 1981

[2]Based on nine month average and not including dormitory credits

CURRENT PROBLEMS

UM's major problem is the high cost for Centrex service and equipment. The July, 1979 rental cost for Centrex was $24,663 compared to $26,196 in July, 1980 and $30,032 in June, 1981. This represents an increase of over 21% in two years.

The approved 40% increase on Centrex access charges will further increase UM's monthly cost from $30,032 to approximately $36,065.

In addition to this primary problem, the following are either technical or operational problems with the current Centrex system:

- Long amounts of time needed to dial a call (lack of touchtone coupled with a frequent "system busy" condition).
- Additional MSTS service needed.
- Inability to answer for faculty calls at a central location.
- Have outgrown the present system.
- Unable to transfer calls that originate from within the university or calls from the MSTS.
- Telesciences toll accounting device at full capacity disallowing additional MSTS access lines.
- Telephone cost allocation to departments is currently done manually and UM would prefer an automated system.
- UM desires to continue providing telephone service to dormitory residents and would like to consider providing service to family housing off-campus.

PROPOSED SYSTEM DESIGN

UM's current ratio of main station lines to telephone sets is 2396 (lines) to 2584 (sets). Utilizing key telephone systems, approximately 188 instruments share a main station line(s). By industry standards, this is a low ratio of lines to sets.

For purposes of this analysis, a PBX model consisting of 2500 main station lines and 2700 instruments was constructed. The existing 602 multi-line instruments were reduced to 300 (50%) and replaced with single-line instruments. Table Fourteen lists the components of this replacement PBX model for UM.

TABLE FOURTEEN
UM REPLACEMENT PBX MODEL

ITEM	QUANTITY	COST
Electronic PBX	2500 Main Stations	$2,000,000.00
Distribution Plant	Complete Changeout	$539,505.00
Telephone Sets	2400 Single-line 300 Multi-line	Included
Trunking		
- direct in dial	72	$2,057.00 monthly $936.00 install
- direct out dial	125	$4,010.00 monthly $1,625.00 install
- direct in dialing service	2100 no.s	$2,724.00 monthly $6,720.00 install
Maintenance	begins in 2nd yr.	$5,400.00 monthly

Based on this model, Table Fifteen projects these costs for a ten year period, utilizing the assumptions discussed in Section II. As with the other universities, this PBX cost is compared against UM's current Centrex costs to provide a financial benchmark. The Centrex cost projection is based on Mt. Bell's service and equipment rental for the month of June, 1981 ($30,032) adjusted to reflect the recently approved Centrex access charge ($36,065).

TABLE FIFTEEN
PBX MODEL VERSUS CENTREX COST PROJECTION
$000's omitted

	CENTREX		PBX MODEL	
YEAR	ACTUAL	PRESENT VALUE	ACTUAL	PRESENT VALUE
1982	$432.8	$389.9	$648.7	$585.3
1983	480.4	389.9	715.8	581.0
1984	533.2	389.9	735.8	538.0
1985	591.9	389.9	758.0	499.3
1986	657.0	389.9	782.6	464.4
1987	729.3	389.9	810.1	433.1
1988	809.5	389.9	840.4	404.8
1989	898.5	389.9	340.2	147.6
1990	997.4	389.9	377.6	147.6
1991	1,107.1	389.9	419.2	147.6
TOTAL	$7,237.1	$3,899.0	$6,428.4	$3,948.7

Table Fifteen indicates a long term savings potential available with the PBX model. Of course, comparing a PBX to a Centrex system for the next ten years is somewhat unrealistic and actually not a valid comparison due to the many technical advantages inherent in a PBX such as automatic route selection and advanced single-line telephone features, which could result in additional savings to UM. Also, due to the pending deregulation of the telephone industry and the obsolete nature of Centrex, it is doubtful that Centrex will be available for the next ten years.

Therefore, the cash flow projection presented in Table Fifteen is for cost estimates. However, since a savings is indicated, TII is recommending that UM solicit competitive bids for a replacement system based on the PBX model. By doing this, a wide variety of actual prices will be obtained and a new set of cash flow projections performed.

Table Sixteen projects an estimated timetable for this project.

TABLE SIXTEEN
MU REPLACEMENT TIMETABLE

ITEM	MONTH
Final System Design	1
Request For Quotation	1
Bids Received	4
Evaluation/Recommendation	6
Award	9
Installation	15
Testing	17
Cutover	18
Acceptance	20
	20 Total Months

DORMITORY SERVICE CONSIDERATIONS

All three Universities currently provide service to dormitory residents as a part of the main Centrex system. A dormitory line, labeled a PS7 on the Mt. Bell service and equipment billing, is charged at $8.70 per month. Each University pays this portion of the cost, which is indirectly allocated back to the students in the cost for a dorm room. Student long distance calling is placed by a credit card at direct dial rates, leaving Mt. Bell wholly responsible for the billing and collection of student toll calling charges.

When Mt. Bell proposed Dimension PBX systems for each University in March, 1980, they recommended that dormitory service be provided by a local line to each room rather than placing the dorm lines on the Dimension PBX. Labled Dormitory Communications Service, "each institution would be billed by Mt. Bell each month for the dormitory telephones and the students directly for all long distance calls.

Long distance calls from the dormitories will be placed by credit card at direct dial rates similar to the existing Centrex system. Mt. Bell will have the responsibility of collecting long distance bills from students. If the dorm rooms were handled by the Dimension, it would cost more per month and students would be charged operator assisted rates for all long distance calls".[1]

However, since that time, Dormitory Communications Service was discontinued. Also, in other states (Idaho) students have been placed on a Dimension PBX and yet Mt. Bell still bills the students directly for long distance calls at direct dial rates, contrary to the March, 1980 proposal statements.

Therefore, the question of including students on a replacement PBX is still an open one and in light of recent "shared use and resale" opinions from the FCC, a question deserving careful consideration.

In the PBX model constructed for each University, dormitory lines were included on the switch and Central Office trunking with adequate DID numbers provided to accommodate these lines. This was done since Dormitory Communications Service was withdrawn as an option and since there are other advantages to placing students on a new system.

The issue is complicated, and for this reason, TII is providing the following discussion regarding the provision of telephone service to dormitory residents.

INTRODUCTION

For a variety of reasons, most universities are evaluating new approaches to providing telephone service to dormitory residents. In some cases, the operating telephone company has discontinued traditional service methods associated with the provision of Centrex service. Other universities have replaced their Centrex systems with modern private branch exchanges (PBX's) either provided by the Bell System (Dimension) or purchased from a private telecommunications supplier.

Regardless of which of these equipment options is involved, there are ways to provide service to dormitory residents and this report addresses the technical and legal ramifications involved with each approach.

BACKGROUND

Historically, university telephone service has been provided by the Bell System as Centrex service, whereby direct inward and outward dialing is provided on a per extension basis. The switching equipment can be located either on the customer's premises (CU) or in the telephone company's central office (CO). In either case, a main listed number will give access to a university operator and individual extensions can also be given a directory number (listed or not).

[1] Telecommunications Proposal for the State of Montana
Mountain Bell, March 3, 1980

The university is then billed monthly by Bell for equipment on a "per line" basis. Also, long distance calling dialed directly (called MTS and usually a dial-9 access) is also billed monthly on a "per line" basis. Access to wide area telephone service (WATS) was usually provided manually by the university operator but in some cases, could be accessed automatically by dial-8.

However, itemized billing (per line detail) is not available on WATS calling, requiring either a manual record-keeping function by the operator for manual WATS access, or a computerized call detail recording device to track dial-access WATS calling (WATSBOX or Datapoint's LDCS).

In the past, dormitory students were provided a Centrex line which was billed as part of the total university system. However, these dorm lines were denied dial access to MTS or WATS calling directly and each student was issued a credit card to charge long distance calling.

Therefore, up to now, Bell provided equipment (lines and telephone sets) to dorm students as part of Centrex and yet remained totally responsible for billing and collection of toll calling. Also, as part of a typical Special School Centrex tariff, students were not allowed access to university owned WATS lines.

This arrangement was ideal for several reasons. First, and probably most important, dormitory residents were provided telephone service at a lower cost than a normal residential line. The cost for each extension was billed by Bell to the university, who, in turn, usually rebilled this cost as part of the cost charged for a dorm room.

Secondly, the university was not responsible for billing or collecting long distance charges from students, a procedure that requires considerable administrative effort.

Therefore, as long as a university utilized a Centrex system and Bell was willing to provide both the long distance billing and equipment capacity on their switching equipment, everything was perfect.

Now, a variety of problems are surfacing which stand to interrupt this situation. In some areas, the local Bell operating company has cancelled (or plans to soon) the provision of credit cards for long distance charging of dorm residence calling. In this case, lacking the equipment or administrative capabilities to perform this billing, a university is faced with removing students from the Centrex system and having each student arrange for individual residential service. This requires a significant deposit and higher monthly cost, sometimes preventing a student from affording a telephone.

Many other universities, under financial pressure from AT&T's "migration plan"[1] have upgraded from Centrex to a private branch exchange. In this case, unless the billing equipment and administrative procedures again can be developed, the students will be forced to fend for themselves.

[1]The migration plan is Bell's strategy to continually raise the price of Centrex, forcing customers into long-term Dimension contracts, protecting their rate base against competition.

In the case of Centrex or Dimension customers, exclusion of students from the system has only one drawback, students must pay more for telephone service. In fact, Bell prefers and recommends this approach for two reasons. First, and most obvious, more revenue is generated utilizing residential service for dorm students. Second, without having to provide lines to students, which sometimes can account for as much as 50% of a telephone system's size, the university's costs appear to be much lower. These proposed lower costs can either delay the replacement of a Centrex system or make a Dimension proposal appear more attractive.

In the case of a university utilizing a purchased PBX, not including students on the system negates a major source of revenue that could contribute towards paying for the system.

For universities contemplating the purchase of a new telephone system, the "cost per line" declines with system size. Therefore, in this instance, including dorm service benefits both the students and the university, financially.

Therefore, to provide economical telephone service to dormitory students and in the case of private systems, allow their contribution towards paying for the system, including students on the system seems favorable.

There are, however, technical and legal problems associated with their inclusion and this report addresses these issues.

TECHNICAL CONSIDERATIONS

Since the technical issues are different for provision of dormitory service via Centrex versus a private branch exchange, they will be addressed separately.

CENTREX

As described earlier, with Centrex service, each user essentially has a private line for access to the public switched network. Calls can be both direct in-dialed and out-dialed. For the administrative users, MTS calls are billed monthly and itemized by extension number, facilitating cost allocation. Dormitory users must give their credit card number prior to making an MTS call, and then Bell bills each student individually.

Administrative users access WATS, foreign exchange (FX) or network access lines (tie-lines) either manually (operator assisted) or dial access with an associated recording device for cost allocation. Dormitory users are denied access to these facilities.

The only drawback with this system is that collect calls to administrative extensions cannot be allocated due to a lack of data. Otherwise, the University receives and bills back administrative toll costs and Bell bills each student individually.

With the anticipated loss of Bell's willingness to be responsible for billing of student calls, one of two things will occur. The students could remain on the system and their MTS charges would be billed to the university just as the administrative toll charges are now. In this case, the university would simply have to handle the additional administrative overhead of preparing, distributing, tracking and collecting these monthly charges.

This would not be a small task. For one thing, the university would have to be prepared to carry these costs for probably sixty (60) days, the period between paying Bell's bill and collecting from the students.

Collect calls to student extensions would be unbillable and could pose a major problem.

For a large system (1,000 lines and above) it would seem that the only manageable cost allocation system would have to be computerized. The monthly MTS bill would be received from Bell on IBM compatible magnetic tape for processing by the university's data center into individual billing statements for distribution to users. The data base could be constructed to include the individual's hardware portion of each month's Centrex charge.

Another major consideration would be allowing students access to WATS, FX and network services. Manual or university operator controlled access to these facilities would be totally unworkable, requiring dial access with an automatic call detail recording device for cost allocation. Stand alone, computerized devices are available which will accept an account code from a user, record their call and create a record. The monthly WATS bill from Bell would then be processed against the university's record of these calls for cost allocation.

There are a variety of legal ramifications involved in this "sharing" of equipment and services which will be discussed in Section III.

From a financial viewpoint, the students receive telephone service at lower rates than the alternative residential service option. For the university, a surcharge added to the student's rate for long distance service could at least recover the cost for administrative overhead.

In fact, at current rates, the university could generate a profit while simultaneously providing lower costs to students. For example, were a university to charge slightly less than operator assisted or credit card rates on MTS calls, while paying Bell the actual direct dialed MTS rate, an overhead of approximately 5% could be generated. Charging students regular direct dialed MTS on actual WATS calls could generate 20% and utilizing specialized common carriers such as MCI, ITT or SPC could generate a 50% profit.

These profit margins are estimates and will vary according to the location of the university and the Bell System tariffs in effect in that state. However, MTS dialed direct, WATS and specialized common carriers will always have a lower cost per minute than MTS operator assisted or credit card calling costs.

In summary, keeping students on a Centrex system will require significant administrative effort to accomplish billing but will lower costs to students for telephone service and could be utilized to generate a profit for the university. On the other hand, removing students from the system will simply result in higher costs for them.

PRIVATE BRANCH EXCHANGE

Unlike Centrex service, a private branch exchange (PBX) provides switched access for all users to a shared group of central office trunks for MTS access, WATS lines, FX and network services. Unlike the less sophisticated Centrex systems, most modern PBX's have the internal capability to record cost allocation data by extension.

Typically, a call record is created on magnetic tape for all toll calls for monthly processing into bills for distribution to each user. Again, this processing is best accomplished by the university's data center with either a licensed, purchased or in-house developed software package.

Like Centrex, a PBX can be equipped for Direct Inward Dialing (DID) whereby incoming calls don't require processing by an attendant. Access to MTS can be dial-9 and access to WATS, FX or network services can be dial-8 followed by an account code for billing purposes.

The same administrative overhead is required with a PBX as with a Centrex system for recording, billing, tracking and collecting toll charges. However, the internal call detail recording system for WATS calls eliminates the need for the stand alone computerized system required with a Centrex system.

The additional advantage of serving students with a PBX is obtaining an ultimate lower cost per line by increasing the size of the system and then letting the dormitory residents contribute towards paying-off the cost of the system. Of course, with a Dimension PBX, this advantage doesn't exist since the system is not being purchased but only rented.

Therefore, the ideal situation would be a university in position to replace their Centrex system with a purchased PBX. The PBX would be equipped for full Direct Inward Dialing, call detail recording and automatic route selection[1]. The university would purchase a bank of central office trunks, WATS lines, FX lines, tie-lines and circuits from specialized common carriers (MCI, SPC or ITT).

A computer data base would be constructed during installation of the system's hardware detailing each users actual equipment. Part of this data base would relate the extension number to the users name, cost center and long distance billing account number.

[1] Automatic Route Selection is a PBX capability whereby the system examines a long distance call attempt, reviews the available choices for completing the call, and automatically selects the least expensive route.

Upon system cutover, the monthly Bell bill for MTS and WATS would be received on magnetic tape. The university would input their required surcharge to recover administrative costs or produce a profit and these costs would be merged with the equipment billing data to produce a monthly service and equipment bill for each user.

During the day, when students are in class, administrators would be the primary users of the MTS and WATS circuits. After hours, as studies have shown, students would utilize these circuits left idle by closed administrative offices. This results in the maximum utilization of costly circuits.

Meanwhile, students receive reduced long distance calling costs, less expensive hardware costs (compared to residential rates) while contributing towards paying for the system.

LEGAL CONSIDERATIONS

In the past, most state regulatory commission tariffs regarding Centrex service for universities, commonly labeled Special School Centrex, prohibited access to WATS lines for "non-business related activity". This prevented students from utilizing WATS lines. Restrictions such as this combined with the problem of cost allocation on MTS and WATS calling created a natural division between administrative and dormitory system users.

However, effective June 1, 1981, the Federal Communications Commission (FCC) issued a ruling allowing both the shared use and resale of the Bell System WATS and MTS services. Now, by deploying the automatic route selection and call detail recording equipment discussed in Section II (stand alone for Centrex or internal with a PBX) universities can take advantage of this recent ruling and provide services to dormitory residents.

Administrative costs associated with providing telephone service to students can now be offset through the resale of services, applying a surcharge on calls to cover the expenses for billing and collecting.

Two options are available. The university may bill and collect from the student an amount equal to the actual per minute usage charge for an operator assisted MTS call as described in AT&T tariff, FCC No. 263 (MTS), plus an additional fee to recover equipment and administrative expenses on a non-profit basis. The other option would be to actually create a profit by the imposition of a larger surcharge.

From a regulatory viewpoint, the issue of non-profit or profit distinguishes a user as either a "resale carrier" in the case of a profit oriented operation or as an ordinary subscriber if no profit is generated.

If a university receives payment or other compensation with the intent to earn a profit, then the university would be considered a resale carrier and then required by the FCC to obtain authorization and file a tariff in accordance with the Commission's rules (described later).

On the other hand, imposition of a per call surcharge for the provision of MTS or WATS does not invariably constitute resale. Strictly speaking, resale is defined as "the subscription to communications services by one entity and its' reoffering of these services to the public for profit". Entities imposing a per call surcharge would be required to obtain FCC Section 214 authority and to file a tariff if the entity profits from provision of that service.

However, if a surcharge merely covers the entity's costs of providing the MTS or WATS service, then that entity would not be engaged in resale and therefore, not required to obtain Section 214 authority.

This is the pure definition distinguishing resale carriers from normal subscribers. Unfortunately, however, due to the lack of precedence in this area and the current uncertainty surrounding the federal and state regulatory environment, the classification of a subscriber as a resale carrier may not hinge solely on this pure definition.

For example, many universities have applied some form of surcharge to WATS and network (tieline for CCSA) calling for years without eliciting any comments from the carrier (Bell System). Yet the visibility that may be created by providing services to students could very well precipitate a complaint.

Therefore, at this time, based on the uncertainty surrounding this issue, Telecommunications International, Inc. is recommending that Section 214 Authority be obtained regardless of whether or not a profit is to be earned. If, once the issue is finally settled by all regulatory bodies and non-profit entities aren't required to be licensed, the Section 214 Authority could be sold (transferred) to a resale carrier.

Therefore, to obtain Section 214 Authority, the following is required[1].

- Complete FCC Form 430 responding to sub-parts of Sec. 63.07A of the FCC's rules.

- The completed application and five copies should be sent to the Secretary, FCC, Washington, DC 20554. A copy of the application should also go to Mr. D. L. Solomon, Dep. Assistant, Office of Ass't Sec'y of Defense (Telecommunications), Rm. 3E160, Pentagon, Washington, DC 20301. Another copy should be sent to Dir. of Telecommunications Policy, Office of Ass't Sec'y of Defense, Pentagon, Washington, DC 20301. Also, the governors of any states in which the applicant plans to do business should also be served with copies of the completed application.

Form 430 is available from Domestic Facilities Div., Common Carrier Bureau, Rm. A-342, FCC, Washington, DC 20554.

[1]Excerpts from Regulation News, Interconnection Publications, Inc., North Hinterlands, P. O. Box 128, Rhinebeck, N.Y. 12572, Vol. VII, No. 3, May,1981, page 3.

Sec. 63.07A can be found in the Federal Register, available at law libraries or larger public libraries. It can also be ordered from Supt. of Documents, U.S. Gov't Printing Office, Washington, DC 20402; send a check for $1 and ask for Vol. 45, Pamphlet #224, Nov. 18, 1980. The rules that apply to 214 applications begin on page 76168. (Be forewarned: it can take 4 to 5 weeks for the GPO to respond.)

Sec. 63.07A can also be obtained from The Downtown Copy Center, 1114 21st St. NW, Washington, DC, 20036. Ask them for FCC Order #80-629 in Docket #CC-79-252. Cost is $17.11 ($.09 per page plus $10 documentation fee); send check or ask them to send the order COD.

However, as you will see after examining Form 430 and the 214 application, the process is lengthy and complicated.

For this reason, TII is also recommending that universities retain legal counsel to insure a successful application.

Specifically, the law firm of Cohn and Marks has represented Duke University, Ohio State and the University of Nebraska in such matters. According to Mr. Edwin B. Spievack, General Counsel for Cohn and Marks, they will handle a 214 application in its entirety for a fee of $5,000 to $7,000.

They have not encountered any problems in obtaining this license and the process typically takes four months. Mr. Spievack can be contacted at 202-293-3860.

In conclusion, while the legal ramifications involved in a university providing telephone service to dormitory students are numerous, they can certainly be overcome and have been by a few universities already.

CONCLUSION

The telecommunications industry is becoming more competitive every day. Out of this increased competition come alternatives for users to consider rather than simply adhering to the mandates of the operating telephone company.

Providing telephone service to university dormitory residents is an example of a decision requiring an evaluation of alternatives. While the Bell System seems to be discouraging the continuation of providing dormitory service under traditional methods, there are viable and attractive alternatives available.

Rather than simply forcing students to obtain residential service where only Bell benefits from the higher costs obtained, a university can take the initiative and both the students and the university can benefit.

For the first time, both the technical, legal and financial avenues are open to allow universities to be innovative in this area and Telecommunications International, Inc. recommends that all options be considered before any decision is made.

While most universities are not necessarily obligated to make a profit, they are obligated to operate economically and provide a proper and affordable environment for their students. Provision of reasonably priced telephone service is a vital part of this environment.

UNIVERSITY SYSTEMS SUMMARY

TII is recommending that Eastern Montana College, Montana State University and the University of Montana solicit competitive bids for modern PBX systems to replace their Centrex systems. This recommendation is based on financial, technical and regulatory considerations.

Each system would be equipped with the automatic route selection (ARS) and station message detail recording (SMDR) capabilities described in Section II. With these capabilities, each University could utilize their own interstate WATS circuits, improving service on the MSTS without having to add costly circuits. In-state calling would be automatically routed to MSTS trunks.

The SMDR capability would provide each University with a detail of all WATS and MSTS calling for cost allocations and account codes could be used to allow allocation by department or grant. This would allow more access to MSTS since any main station line can be monitored by SMDR.

There are many other advantages to a modern PBX which will become more apparent as each university receives proposals from different vendors. From a financial viewpoint, replacing these Centrex systems with PBX's will result in a significant, long-term reduction in many aspects of each University's communications costs even though the cash-flow projections presented in this section comparing "hard dollar" costs of Centrex versus the PBX in some cases were not initially significant. These costs were compared against the existing Centrex systems costs only to provide a form of benchmark and to allow each University to observe the difference between renting and purchasing a telephone system.

However, as previously discussed, making a financial comparison of Centrex to a PBX estimate, is unrealistic for a variety of reasons. First, it is highly doubtful that Mt. Bell would allow the continuation of Centrex for an additional ten year period. With deregulation pending and Bell's migration strategy in full swing a ten year Centrex projection is only useful as a financial benchmark. From a cost point of view, these projections appear to show an insignificant long-term savings over the PBX model, in some cases. These tables also indicate a higher up-front cost for the PBX for the first seven years. In actuality, there are many "soft dollar savings" available with a PBX that are not included in this projection, such as reduced administration costs (adds, moves and changes) and reduced long distance calling costs. In addition, the other State agencies served by these systems will contribute towards paying these costs. Lastly, by utilizing the variety of financing options available to a tax-exempt State agency, the initial, higher, up-front costs could be easily smoothed out over the ten year life of these projections. In conclusion, these projections are a preliminary comparison of estimated costs for a PBX only and after bids are received true costs will be utilized to perform similar projections and thereby providing each University with a more realistic cash flow projection.

An exhaustive cash flow analysis process will be performed utilizing all available financing options to most closely emulate each University's current telecommunications budget.

SECTION IV

HELENA CAPITOL COMPLEX

EQUIPMENT & COST PROFILE

Telephone service for the Helena Capitol Complex (HCC) is currently provided via a Mt. Bell Centrex system based on a #5 crossbar electromechanical switching vehicle located on telephone company property. Table Seventeen lists the various components of the HCC system.

TABLE SEVENTEEN
HELENA TELEPHONE EQUIPMENT

DESCRIPTION	QUANTITY
#5 Crossbar Centrex System	1.
Main Station Lines	1566.[1]
Telephone Instruments	3590.[1]
Network Tieline Terminations	168.
Network WATS Line Terminations	55.

This Centrex system provides direct telephone service to both the Capitol Complex and a variety of other State agencies located throughout Helena. In addition to providing direct telephone service, the Helena system also serves as the hub for the Montana State Telephone System (MSTS) described later in this Section.

This system costs an average of $95,720 per month for equipment rental, moves and changes in equipment and long distance either dialed direct, collect, credit card or third party billing.

This does not include the costs for MSTS (agency access lines and WATS lines) which is recovered from the various users and discussed later.

Table Eighteen gives a breakdown of this monthly cost.

[1] Based on Mt. Bell Service and Equipment billing record for June, 1981.

TABLE EIGHTEEN
HELENA CENTREX COSTS

DESCRIPTION	MONTHLY COST	PERCENTAGE
Centrex Equipment Rental	$75,338.00	78.7%
Other Charges & Credits	6,117.00[1]	6.4
Long Distance	14,265.00[2]	14.4
TOTAL	$95,720.00	100.0%

CURRENT PROBLEMS

By far the major problem with the Helena Centrex system is financial. Table Nineteen gives an example of this problem by presenting the increases in annual expenditures in Helena for Centrex service and equipment (S&E) and the costs for adds, moves and changes (OCC's).

TABLE NINETEEN
HELENA CENTREX COST INCREASES

YEAR	S & E	OCC
1975	$359,657	$20,904
1976	405,649	24,760
1977	477,701	31,320
1978	497,917	27,683
1979	673,895	43,520
1980	738,100	73,121

Therefore, during the last six years, the cost for Centrex service and equipment has increased over 105% and the cost for adds, moves and changes has increased over 249%. Although the Helena telephone system has grown in equipment during this period, the growth has not been at all proportional to these cost increases.

For example, in April, 1981, the Helena system consisted of 1632 main station lines, 3678 telephone sets and the Centrex S&E cost was $70,993. By July, 1981, system size had decreased to 1566 main station lines and 3590 telephones, yet the Centrex S&E cost had increased to $75,338.

A 4% reduction in equipment resulted in a 6.1% increase in monthly rental charges.

The recently approved Centrex access charge adjustment (40%) will increase the HCC's monthly service and equipment billing from $75,338 to $78,334.

[1] This is the cost from Mt. Bell to add, move or change equipment and is based on an average for the period from August, 1980 thru July, 1981.
[2] This is the cost for "non-network" long distance calls such as collect or credit card calls and is based on an average for the same period as Note 1.

Another major problem with the current HCC Centrex system is the large number of main station lines serving remote (off-premise) locations throughout Helena. Although under the current Centrex tariff, no mileage charges are being assessed for these circuits. When considering the replacement of Centrex with a PBX, the State would incur an additional $47,000 per month in mileage charges alone to serve these off-premise extensions.

Therefore, as will be discussed in more detail in the next section, TII has constructed two PBX replacement models. Model One utilizes a single PBX serving all current HCC locations with all current off-premise extensions (OPX) provided circuits identical to the Centrex system. Model Two places several PBX's at Helena locations outside the Capitol complex and uses tielines (or microwave radio) to connect each of these locations.

In addition, the following problems exist with the current HCC Centrex system:

- "After the 9/81 rate increase, the existing equipment will be obsolete relative to new equipment cost effectiveness and flexibility." Communications Division

- "Agencies are required to budget for communication costs to be incurred over a two-year period. Rate increases are authorized to be effective at any time ... (which can cause) a significant impact on our budget." Administration

- "Operators don't always pick up on a transfer signal. Incoming callers that need to be transferred to another office are often hung up on." Administration

- The following capabilities would facilitate telephone operations:

  - o Call waiting
  - o Call hold (single-line sets)
  - o Hunting
  - o Intercom
  - o touchtone
  - o Call forwarding
  - o Individual call transfer
  - o Call pickup
  - o Queueing
  - o Camp-on
  - o Add-on conferencing

- A "system busy" condition is frequent.

- "The largest problem encountered by administrators, in order of severity, were escalating costs, inadequate switch expansion capability, facilities inadequacy (lack of cable), incorrect billings and poor turnaround times for completion of orders."

- As the hub for the MSTS, the HCC switch should provide considerably more network capabilities such as a control center, ARS and SMDR than is currently available with Centrex.

PROPOSED SYSTEM DESIGN

There are two approaches to replacing the HCC Centrex system. One approach would utilize a single PBX system located on the complex. Other State agencies located outside of the complex would be served as OPX locations, just as they are now. The primary drawback to this approach would be the significant monthly mileage charges assessed to these OPX circuits ($47,000 monthly).

To assess the cost of this approach, TII constructed PBX Model One consisting of a single PBX equipped with 3400 main station lines and 3600 telephone sets. This model would utilize 3400 single-line telephones and 200 multi-line telephones, either standard (1-A2) key or electronic. Table Twenty lists the components of this replacement PBX Model One.

TABLE TWENTY
HCC REPLACEMENT PBX MODEL

ITEM	QUANTITY	COST
Electronic PBX	3400 Main Stations	$2,720,000.00
Distribution Plant	Complete Changeout	$760,000.00
Telephone Sets	3400 Single-line 200 Multi-line	Included
Trunking		
- direct in dial	130	$3,715.00 monthly $1,690.00 install
- direct out dial	220	$7,057.00 monthly $2,860.00 install
- direct in dialing service	3300 no's	$2,264.00 monthly $10,560.00 install
Maintenance	begins in 2nd yr.	$7,200.00 monthly
NCP Mileage (OPX)	existing levels	$47,000.00 monthly

Based on this Model One, Table Twenty-One projects these costs against the HCC Centrex system based on the July, 1981 service and equipment billing adjusted to reflect the new access charges ($78,334 monthly).

TABLE TWENTY-ONE
PBX MODEL ONE VERSUS CENTREX COST PROJECTION
$000's omitted

	CENTREX		PBX MODEL	
YEAR	ACTUAL	PRESENT VALUE	ACTUAL	PRESENT VALUE
1982	$940.0	$846.9	$1,467.1	$1,323.2
1983	1,043.4	846.9	1,617.7	1,313.0
1984	1,185.6	846.9	1,823.4	1,254.1
1985	1,285.6	846.9	1,823.4	1,201.1
1986	1,427.0	846.9	1,943.5	1,153.4
1987	1,584.0	846.9	2,076.8	1,110.3
1988	1,758.2	846.9	2,224.7	1,071.5
1989	1,951.6	846.9	1,657.3	719.1
1990	2,166.3	846.9	1,839.7	719.2
1991	2,404.6	846.9	2,042.0	719.2
TOTAL	$15,718.9	$8,469.0	$18,407.3	$10,584.1

As Table Twenty-One clearly indicates, utilizing a single PBX and paying mileage charges to all OPX locations is more expensive than the current Centrex system.

Therefore, PBX Model Two utilizes a central PBX at the Capitol Complex and seven (7) smaller PBX's located throughout Helena at areas with a high concentration of main lines. These remote or "satellite" PBX's would connect to the Capitol PBX via tielines and this operation would be practically transparent to the users. Utilizing centralized attendant service coupled with full Direct Inward Dialing, a uniform numbering plan and central answering point would still exist. In this way, a significant cost reduction would result from the elimination of a large amount of the mileage charges which resulted in the high costs demonstrated by PBX Model One.

Table Twenty-Two lists the various components of PBX replacement Model Two and Table Twenty-Three projects the estimated costs based on this model.

TABLE TWENTY-TWO

HCC REPLACEMENT PBX MODEL TWO

Equipment costs	$2,774,850.
Distribution plant	$760,000.
Trunking	
- Monthly	$10,702.
- Install	$4,537.
Tielines	
- Monthly	$1,476.
- Install	$533.
Maintenance	$7,202.
NCP Mileage (monthly)	$18,330.
DID Service	
- Monthly	$2,264.
- Install	$10,560.

Table Twenty-Three projects the cost of the PBX Replacement Model Two against the HCC Centrex system.

TABLE TWENTY-THREE
PBX MODEL TWO VERSUS CENTREX COST PROJECTION
$000's omitted

	CENTREX		PBX	
MODEL				
YEAR	ACTUAL	PRESENT VALUE	ACTUAL	PRESENT VALUE
1982	$940.0	$846.9	$1,152.0	$1,039.4
1983	1,043.4	846.9	1,266.0	1,027.5
1984	1,158.2	846.9	1,323.5	967.7
1985	1,285.6	846.9	1,387.4	913.9
1986	1,427.0	846.9	1,458.3	865.4
1987	1,584.0	846.9	1,537.0	821.7
1988	1,758.2	846.9	1,624.3	782.4
1989	1,951.6	846.9	978.1	424.4
1990	2,166.3	846.9	1,085.7	424.4
1991	2,404.6	846.9	1,205.1	424.4
TOTAL	$15,718.9	$8,469.0	$13,017.4	$7,691.2

As Table Twenty-Three shows, PBX Model Two is significantly less costly than PBX Model One due to the reduction in OPX mileage charges. However, a multi-PBX system will be more difficult to administer than a single PBX.

TII is recommending this multi-PBX approach rather than a single PBX serving all current HCC Centrex users. However, prior to a final system design and creation of a formal Request for Quotation (RFQ), some discussions with these remote users should occur to insure their needs are fully met.

SCHEDULE

Figure Three illustrates the proposed schedule for replacing the HCC Centrex system.

NETWORK REQUIREMENTS

As mentioned earlier, the HCC Centrex switch acts as the hub for the Montana State Telephone System (MSTS). The MSTS is a network of 168 access lines (tielines) and WATS lines. These tielines interconnect 13 Montana cities and the HCC.

"Each outlying city or circuit group has a designated three-digit code for access. The WATS circuits are flat rate, long distance circuits originating in Helena and serving all areas of Montana not connected by tielines, including the continental United States. The Montana WATS line code is accessed with the three-digit code "151", while the nationwide WATS service uses "171" for access. All WATS calls are logged for statistical analysis and cost allocation.

The MSTS presently operates a dial tandem network consisting of 168 tielines to various Montana cities, 34 intrastate WATS, and 21 interstate WATS. The system is presently switched through the Helena number five crossbar by use of access code "8" from all authorized satellite stations, followed by the appropriate three-digit code".

The State of Montana presently has a station message detail recording (SMDR) system consisting of Telesciences equipment at each University and the Capitol complex. The message information for each location is stored on a Hewlett Packard Mag Tape unit in Helena. The mag tape is in turn programmed into the State's IBM 370-158 computer. The resulting information print-out contains the station placing the call, the duration of the call and the number dialed.

From this information each user is billed at 14¢ per minute.

The MSTS costs approximately $1,378,260 annually (see Figure One). Table Twenty-Four gives a breakdown of the MSTS cost components.

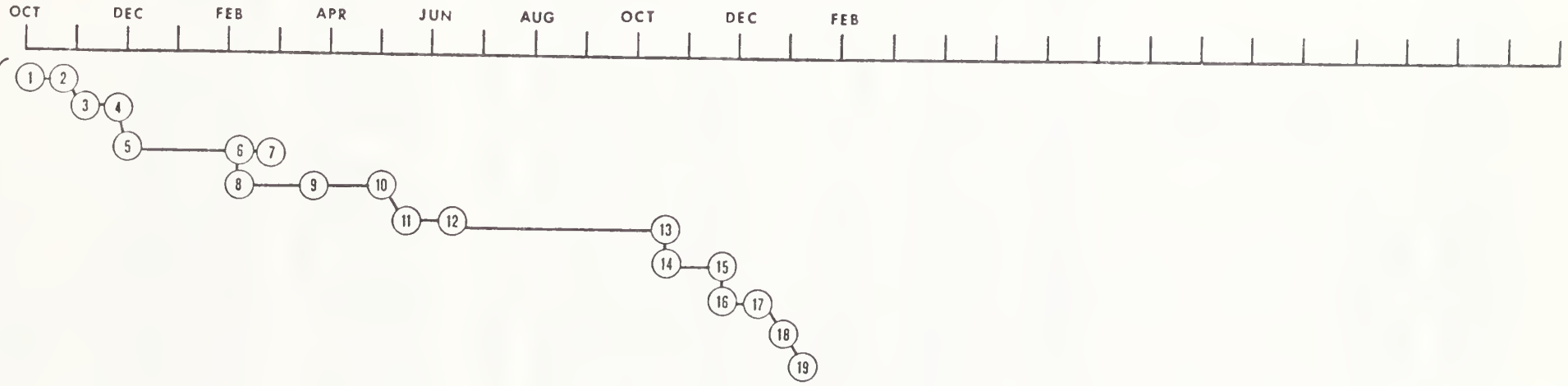
TABLE TWENTY-FOUR
MSTS COST COMPONENTS - 1981

DESCRIPTION	ANNUAL COST
Access Circuits (168)	$465,024.
WATS Circuits	$837,060.
Telesciences (SMDR)	$63,912.
Usage Meters	$7,800.
Toll Restriction	$4,464.
TOTAL	$1,378,260.

CLIENT: HELENA CAPITOL COMPLEX

30 UNIT CRITICAL PATH MAP

PROJECT START: OCT. 5. 1981



COMPONENT IDENTIFICATION

1. PREP. RFQ AND EVALUATION MATRIX
2. REVIEW RFQ DRAFT
3. RELEASE RFQ
4. PRE-BID CONFERENCE
5. SITE SURVEYS
6. BIDS DUE
7. VENDOR PRESENTATIONS
8. TII RECOMMENDATION
9. CONTRACT AWARD
10. NOTICE TO PROCEED
11. BEGIN OUTSIDE STAT.ON PLANT
12. BEGIN INSIDE STATION PLANT
13. SWITCH ROOM READY
14. SWITCH ON SITE
15. SWITCH TESTING
16. STATION TESTING
17. CUTOVER
18. SHAKEDOWN
19. ACCEPTANCE

REMARKS

TII 1-81

FIGURE 3.

The costs for MSTS have risen dramatically over the past few years. Table Twenty-Five illustrates the MSTS costs since 1975.

TABLE TWENTY-FIVE
MSTS HISTORICAL COSTS

YEAR	COST
1975	$382,947.
1976	$401,690.
1977	$517,142.
1978	$793,874.
1979	$751,501.
1980	$870,427.

Of course, a large portion of these costs are "usage sensitive" and yearly increases reflect increased use. However, the equipment portion (access circuits particularly) are subject to the same inflationary pressure as the Centrex systems.

Under the current billing arrangement for the access circuits, referred to as "Telpak", Mt. Bell has requested that Telpak be "grandfathered". This would mean no additional circuits allowed under the current billing arrangement.

There are three fundamental problems with the current MSTS which a PBX-based system would ease. The primary problem, again, is cost. When Telpak is grandfathered, adding new circuits to MSTS would significantly increase the networks costs.

The current MSTS system is providing a poor grade of service (GOS), which is primarily due to congested access lines. However, alleviating this problem by adding more tielines would only increase the first problem, high costs.

The last problem is administering MSTS; monitoring usage and allocating costs back to users in a credible manner. The Telesciences SMDR device is obsolete. It has been "manufacturer discontinued" which means it cannot be expanded and maintenance will become a problem in the future.

Also, with the Centrex switch as the MSTS hub, no network monitoring or control is available.

Placing a PBX in Helena would allow greater network control capabilities by allowing State personnel to test circuits and monitor usage. The sophisticated SMDR capabilities would greatly improve cost allocation methods. The automatic route selection (ARS) capability would simplify dialing routines and could even result in lower costs for toll calling.

By placing PBX's in the three Universities, each equipped with SMDR and ARS, the network GOS and ultimate network costs can be improved. Utilizing ARS, each University could have its' own bank of interstate WATS circuits, freeing up congested MSTS circuits for in-state traffic. The user would simply dial the desired number and ARS would decide whether the call went directly to a WATS line, or on to the MSTS. Each systems SMDR would record these calls for billing purposes.

Therefore, by replacing the studied Centrex systems with modern PBX's, cost and service on the MSTS would be markedly improved.

To provide an example of how dialing would be simplified via a PBX, the following excerpt from Rolm's proposed CBX system is provided.

"The network dialing plan could be simplified considerably with the installation of the Rolm CBX. With the CBX, a user would dial 9 + seven digits to place a call on the State Telephone System network. The 7 digits would be the actual listed telephone number for the party desired. To call Helena from Missoula, a user would dial 9-449-2348, where 9 is the access code for an outside call, 449 is the exchange in Helena, and 2348 is the extension in Helena that you wish to speak with. Through the use of routing tables, the CBX would route the call over the tieline network. For a call to Helena, but not to a State agency location, a user would dial 9-1-449-6293, where 9 is the access code, 1 designates long distance, and 449-6293 is the number of the party you are trying to reach in Helena. This call would also be routed over the tieline network, but there would be no need to pause for dial tones along the way and dial a 9 to go off the network at the end point. The interstate WATS calls would be routed over the proper tielines and then switched to the WATS in Helena through the use of tables in the memory of each CBX. The method described would be a universal dialing plan even for non-Rolm locations, however, the non-Rolm locations would need to dial 8 to gain access to Helena PBX, and from then on, they could dial as everyone else, 9 + 7 or 10 digits."

SUMMARY

In conclusion, a wide variety of cost and service improvement potentials exist in replacing the HCC Centrex system with a modern PBX. TII is recommending that a formal Request for Quotation be prepared for solicitation of competitive proposals from the telecommunications marketplace.

SECTION V

RECOMMENDATION

Based on financial, technical and regulatory considerations, TII is recommending that the State of Montana issue a formal Request for Quotation for electronic PBX systems to replace the Centrex systems at the Helena Capitol Complex, Eastern Montana College, Montana State University and the University of Montana.

From a cost viewpoint, a potential long-term savings of approximately $5,350,000 is indicated at the end of ten years. This is based on TII's estimate of costs for PBX's closely approximating each existing system in the number of lines and telephone sets. Once actual bids are received, new cash flow projections can be performed, utilizing a variety of financing options, to project true costs.

Other cost reduction potentials are inherent in this recommendation such as long distance calling and costs for adds, moves and changes in equipment. However, these potential savings were not included in these projections due to their subjective nature.

Technically, Centrex is obsolete. Modern PBX's provide a multitude of time-saving features and capabilities which would improve telephone operations and could reduce personnel costs (secretaries at Universities during summer months). The current poor grade of service could be improved without adding costly MSTS circuits.

Lastly, from a regulatory viewpoint, Centrex is obsolete. Mt. Bell is gradually discontinuing various Centrex offerings (dial intercoms for example) and there is a well-recognized program underway to price Centrex out of the market (migration strategy). This, coupled with the pending Federal deregulation of the telephone industry, would eventually force the State of Montana into a new telephone system, probably within two years.

Therefore, TII is recommending that the State take the initiative now, while project timing is still in State hands, and begin acquisition of new systems by soliciting proposals for replacement PBX's.

The plan and schedule for this project is illustrated in Figure Three, Section IV.

APPENDIX C

A PRELIMINARY STUDY OF THE FEASIBILITY OF ALTERNATIVE METHODS OF TRANSMITTING VOICE, DATA AND TEXT BETWEEN LOCALITIES IN THE STATE OF MONTANA

STATE OF MONTANA

DEPARTMENT OF ADMINISTRATION

COMMUNICATIONS DIVISION

A PRELIMINARY STUDY OF THE FEASIBILITY OF ALTERNATIVE METHODS OF TRANSMITTING VOICE, DATA AND TEXT BETWEEN LOCALITIES IN THE STATE OF MONTANA

ASSOCIATED P & C ENGINEERS, INC.
P. O. BOX 20097
BILLINGS, MONTANA 59104

OCTOBER, 1982

NARRATIVE

SCOPE

The primary task of this report is to assist the State of Montana in its responsibility to provide for the future communication requirements of its various government functions. Specifically, this report should assist in the definition of the most technically effective, reliable and cost efficient communication plan. The primary emphasis of this study is to define the requirements of the state communications network and to analyze alternative transmission methods for that network.

To accomplish this purpose, the following five areas will be addressed in this report:

1. Definitions of the present state network
2. Projections of future communication requirements
3. Definition of the future communications network
4. Comparison of alternative transmission methods
5. Summary of results

I. Present State Communications Network

The present state communications network consists of a transmission portion and a switching portion. The transmission portion is defined as those facilities which transport or carry circuits from one locality to another. For example, Telpak facilities carry circuits from Helena to Havre.

Transmission Portion

The transmission portion of the state network presently consists of the following circuit facilities:

WATS Lines
Telpak Lines
Direct Distance Dialing Lines (DDD)
Dedicated Leased Lines

A discussion of each line type follows.

WATS Lines are incoming or outgoing measured service long distance lines. These OUT-WATS and IN-WATS lines are purchased from Mountain Bell for either intra-state or inter-state calling areas. Intra-state lines serve the Montana calling area and inter-state lines serve outside Montana. IN-WATS lines, also designated as "800" numbers, are limited to incoming calls whereas OUT-WATS is limited to outgoing calling. The monthly charge per line is determined by the number of bands purchased and the total monthly minutes of use.

Telpak Lines are groups of circuits to selected Montana localities which are purchased from Mountain Belll. The State has selected the routing of the circuit groups to serve those locations with the greatest usage. The groups are available in sizes of 12, 24, 60 and 240 circuits. The circuits are terminated per tariff for either switched voice or dedicated service. The switched voice circuits are connected to the state switching network which allows the user to dial various state office extensions or WATS lines. The dedicated service consists of point-to-point voice and data circuits. The dedicated voice circuits are used for closed networks such as the METS teleconferencing system originated from Billings. Dedicated data circuits provide data transmission for low and high speed data networks operated by the Computer Services Department. Examples are the LENS network for law enforcement use and the proposed DECNET for networking the state computers. The high speed data lines require special transmission conditioning and termination per Mountain Bell's tariff. The Mountain Bell tariff limits the maximum voice band data rate to 9600 Baud.

Telpak service is a filed tariff with the State of Montana. The monthly fee varies, depending on the route or routes the circuit travels through, the quantity of circuits in that route and the type of termination for the circuit. Because Telpak is a tariffed service, it is subject to revision and rate increases by Mountain Bell. A 53.6% rate increase is presently pending in the State Public Service Commission and revisions are approved which limit Telpak service to only the existing locations. Exhibits 1-1 and 1-2 show the existing

Telpak routes and describe the capacity and present usage of each portion of the Telpak route.

Direct Distance Dialing (DDD) The Direct Distance Dialing network is utilized for communication with those points that are not served by Telpak or where WATS lines are not available to the user. These lines are regular business lines and are billed as such. Each toll call is individually rated and listed on a monthly bill, along with the local monthly service charge. Direct Distance Dialing is more expensive than the other circuits previously described.

Dedicated Leased Lines - Dedicated Leased Lines are point-to-point circuits leased on a monthly basis by the various government agencies. These lines are utilized for services that always communicate with the same point or points. Dedicated data lines from Helena to Missoula are an example of this type. Specialized circuits such as Land/Mobile base station control circuits also utilize dedicated leased lines from their control point to the transmitter base station. Other examples of leased lines are the Law Enforcement Telecommunications System (LETS), The Montana Educational Telecommunication System (METS) and the dedicated emergency service lines.

Switching Portion

The switching portion of the state communications network consists of the digital PBX and key systems located in the various government agencies. This equipment performs the function of switching calls between outside lines, individual extensions and PBX/key system operators. For the larger locations, a tariffed service called Centrex is utilized. Centrex provides switching for PBX trunks, key system trunks and selected individual extensions. This equipment is usually located in the telephone company's central office. Exhibit 2 shows the location, type of switch and line capacity of the switches presently in use in the state system. Due to the 1968 Federal Communications Commission deregulation of terminal equipment, a user now has a choice of purchasing such equipment or

leasing the equipment from the telephone company or other sources. The Department of Administration has recently analyzed state switching requirements and has awarded a bid to Centel Business Systems to provide Northern Telecom SL-1 PBX's for the Missoula, Helena, Bozeman and Billings state complexes. These new switches are part of a new generation of switching which are digital processor controlled and, therefore, can offer features which increase the efficiency of their users. These switches also have tandem switching capability which is important to the future network. It is anticipated that more of the present switching equipment will be replaced in the future.

II. Present State Communications Network Users

An understanding of the present state communications network users is essential to any analysis thereof. The Communications Division of the State Department of Administration has analyzed the usage of the state communications network utilizing several criteria. The results of this analysis are listed in Exhibit 3. Usage has been analyzed according to the top ten long distance users, including and excluding state universities, the top ten users of leased lines, the top ten users of the state telephone system, and finally, the total usage of all state communications network facilities, excluding the universities. This analysis was obtained by comparing the communication expenditures of the various departments for the last fiscal year. In order to appreciate communication needs of the various departments, data concerning each department, the number of field offices and a description of the field offices is included in Exhibit 4. It is noteworthy that there are 617 field offices located throughout the state. The need to communicate between these offices is obvious.

Appendix A of this report is a detailed list of the departments and locations of the field offices.

Land/Mobile communication networks are maintained by the Highway Department, State Lands Department, Fish, Wildlife & Parks Department

and the Highway Patrol. A radio communication system is essential for these users because many of their personnel are constantly on the move or are located at work sites that vary from day to day. In order to dispatch information to these personnel, a base station must be activated by its associated control station. These two stations are normally not at the same location and, therefore, require a communications link between them. This communications link can be a dedicated radio link or a leased line. For example, in order to dispatch someone in Glendive from Helena, a control link between these two locations would be required. Presently many of these base stations are controlled regionally rather than centrally from one point. In order to obtain central dispatch, additional control links would have to be developed. It is anticipated that this will be the case. Exhibit 5 shows the location of the base stations and control points for the land/mobile radio systems presently in use. Exhibit 5-5 shows the proposed highband system for the Highway Patrol. This system is being phased in with Great Falls as the initial phase.

Several departments maintain information networks. These information networks connect their main agency centers with their outlying offices. For example, the MSU Extension Service has an AGNET which is a dial up network. The headquarters are at Bozeman and the users are extension agents in each county. The Montana Educational Telecommunication System (METS) is headquartered at Eastern Montana College in Billings. They have dedicated lines and dial up lines to various learning centers throughout the state. This system enables students and teachers to communicate with each other remotely. The METS system utilizes the Telpak circuits where they are available and leases lines from the local telephone companies where Telpak is not available.

The State Library maintains an inter-library network which is microcomputer based. This network enables libraries throughout the state to located and obtain books from other libraries. The headquarters office in Helena also maintains a 4,800 BAUD data line

between Helena and Pullman, Washington. The seven largest libraries in the state lease similar data lines from their locations to Helena so they can also obtain the inter-library loan service from Pullman. Exhibit 6 shows the locations of these information networks.

The Computer Services Division maintains a complex network of data communication lines between many localities. One of the users of these lines is the Law Enforcement Network Service (LENS). This system gives on line bulletins and information requests to the participating law enforcement agencies. This system uses the Telpak circuits where available, but in other cases, it requires leased lines from the local telephone company. It is anticipated that more users will connect, especially if network access is less costly.

One of the prime users of the dedicated data lines is the university system. They use these lines to connect their computers to other state computers in order to obtain data bases and for such uses as payroll processing with the centralized computer in Helena. The present system does not lend itself to connecting all the computers on a high speed basis. The Computer Services Division is investigating a system such as DECNET to implement the interconnection of the state's computers. One advantage of dedicated lines which should be recognized is that many low speed data sets can be tied to a high speed data set at a terminal location. Thus, five or six low speed data lines will only require one physical data line for transmission to another point. Utilizing this method of data multiplexing is the most efficient way to increase the capacity of the existing system. Exhibit 7 details the existing data communication lines, data speed and terminal locations in the state.

III. Future Communication Requirements

There are many factors which can influence future communication requirements. First, a discussion of some of these factors will be presented as it applies to the State of Montana and, second, circuit growth projections will be developed based on these factors.

Growth Factors

Increased usage of the state's communication network is expected because of the following primary factors:

1. "Office of the Future" concepts
2. Increased use of data processing equipment
3. Potential inclusion of other government agencies in the state system

The Communications Division of the Department of Administration surveyed the state's departments to determine their future communication plans. This survey confirms that the trend is to implement the "Office of the Future" plans and an increase in data processing capabilities. The term "Office of the Future" refers to the integration of all office operations with a data processing system. For example, a local word processing system would be used to prepare correspondence and the correspondence would be stored in a centralized computer. The transmission of this correspondence would be by data lines to other similarly equipped word processing locations. The function of transmitting correspondence via data lines is referred to as "Electronic Mail". The example described is a simplified form of this. Also integrated into the future office is the facsimile machines for transmitting text and pictures from hard copies and the development of a work station concept. A work station is a CRT terminal and a telephone integrated into one unit. The employee using this work station would have access to common data bases involved with his work and would also be able to communicate with other work stations by voice or data. For instance, messages, text or diagrams could be transmitted to selected work stations throughout the state. The equivalent of copy machines would also be integrated into the automated office. Until recently, the "Office of the Future" was a concept but several companies now offer such integrated systems and although there is not yet a common interface standard, the trend is toward the integrated office concept. Increased productivity and management control are the primary reasons for this trend.

The trend in data processing is toward distributed data processing with data links to the central processor. To the State of Montana, this would mean that an increased number of small computers would be linked with data lines to the centralized processing facility at Helena. For example, Drivers License Bureaus and County Revenue Departments could process some of their data locally and then update master files maintained at the Helena main computer center. Another example would be the potential use of data collection cash registers for all of the state's liquor stores. These cash registers could be queried by a central computer and the results would be instantly available for management decisions, such as inventory control. A current example of distributed processing is the preparation of payroll on the university's computer and then the transmittal of that data to Helena via high speed data lines.

Because of these concepts, there is an increased requirement for data lines projected. Exhibit 8 shows the Computer Services Division future data communication lines.

An additional growth factor to be considered is the potential of other government agencies desiring to use the state communications network. The municipal and county governments, school districts and other political subdivisions realize that their communication requirements are also increasing along with the associated costs of such services. Therefore, they should be interested in utilizing the state communications network if they can reduce their costs. An important part of the future state network would be provisioning for cost accounting to all users. It is also possible that some federal agencies would find it cost effective to utilize the state network.

Circuit Growth Projection

Projections for future circuit quantity growth were developed, based primarily on past growth history and results of the aforementioned survey. Exhibit 9 tabulates historical circuit quantity data from 1963 to the present year of 1982. This data was analyzed,

using the least squares method of future projections and was graphed. This method gives more weight to recent years' trends than to earlier years in the study. Because calling efficiency increases with trunk size, the call handling capacity of the trunks was projected rather than the trunk quantity. Capacity is measured in CCS units (hundred call seconds). The increase in calling efficiency is explained by the Erlang traffic theory that doubling the trunk quantity more than doubles the traffic handling capacity. For small trunk quantities, the factor can be three times the traffic handling capacity. The basic theory is that the more path choices there are, the higher the probability of obtaining a free path. Exhibits 10-1 through 10-8 are graphs of the historical circuit growth and projections of future circuit growth for individual trunk groups listed in Exhibit 9. Exhibits 9 and 10 represent data only for the state communications network lines that are switched and do not represent state dedicated voice and data lines. Future dedicated lines were projected, utilizing the results of the department communication surveys conducted by the Communications Division. Exhibit 8 is an example of the survey data. Exhibit 11 is a tabulation of present dedicated line users and projected line users, such as represented by the Land/Mobile Radio System Control circuit requirements. It is projected that a user, such as the Department of Revenue, will have data lines to almost all counties by 1987. It must be remembered when projecting data lines that as previously mentioned, several low speed modems can be multiplexed onto a high speed modem, thereby increasing the efficiency of the data lines. It is therefore anticipated that much of the increased demands for data services can be met by first increasing the speed of the data lines before additional lines need be added. The present Telpak circuits are limited to 9600 Baud whereas a digital transmission system is capable of 56K Baud. Projections of future dedicated voice and data lines were made from the Exhibit 11, 1987 base quantities. It was desirable to have distributed growth for the dedicated lines so each site was projected at the same rate as the switched circuit growth. This usually provided an increase of one circuit per site per five-year interval. This growth is believed to be quite conservative. Exhibits 12-1, 12-2 and 12-3 tabulate the circuit requirements for

1987, 1992 and 1997 respectively. The quantities shown on these exhibits represent circuits that will be terminated at each location for use by that location. This quantity is not necessarily the same as the quantity of circuit channelized in an actual transmission plan. This is because some locations perform additional functions such as regional switching centers. Also as a practical matter, circuits sometimes are channelized at junction points in order to group the circuits to specific locations, thus increasing the efficiency of the transmission system. Utilizing the circuit quantities in Exhibit 12, trunking plans were developed for specific transmission routes.

IV. Proposed State Communications System Network

Selection of Termination Points

The first task in developing a proposed communications network is to determine the localities that will be served by the network. The Communications Division of the State Department of Administration has analyzed each communication user and each locality for its communication requirements. They have developed a decision matrix which allows points for each factor considered to be important to the selection of a communication system termination locality. Exhibit 13 presents this decision matrix and tabulates the total points for all the major population centers. A minimum of five points is required to be on the state network, unless the network is routed close to a locality. Some potential sites with five points were considered too remote for the initial state network. As a matter of additional explanation, state agencies were ranked as either major users of communications or as minor users of communications. The tabulation of state agencies in Exhibit 13 only considers major communications users. Exhibit 14 tabulates the quantity of state offices per location, regardless of their status as a major or minor communication user. The selection of potential communication sites is difficult at best and the decision matrix allows a logical analysis and can be documented for all concerned parties to see. This site selection list is not presented as a final definite list, but is presented for consideration of its

merits. The sites thus selected will be used for termination points for each transmission plan to be studied.

Proposed Communications Network Configuration and Features

This section describes the physical configuration of the proposed network and its optional features. Exhibit 15 shows each selected terminal location site and its regional switching area. You will note that there are six such regional switching areas. An explanation of the regional switching area concept follows.

Regional switching areas are proposed primarily because of transmission efficiency gains and network reliability advantages. When calls can be switched within their area, transmission facilities from that area to other areas can be sized smaller. For example, in the Glendive regional area, a call from Wolf Point to Sidney would not have to pass all the way through the system back to Helena, but would only require transmission facilities from Wolf Point to Sidney and the regional center at Glendive. This would be valid for calls between any point located within the same regional switching center. The regional switching centers are set up to serve an area of common local calling interests. Only calls between regions will utilize transmission facilities between these regions. The alternative to the regional switching center would be a network whereby all terminal localities would be linked to the center in Helena. This method would require greatly increased trunk quantities.

A second advantage to the regional switching center is that a transmission failure outside of the regional center would not affect calling between localities in that center. For example, a failure in the Missoula-Helena transmission facility would not prevent calling between Kalispell, Polson, Hamilton or Missoula. Because dedicated lines are not switched, the regional switching center concept does not apply to them, except that it is proposed that all dedicated circuits will terminate at a regional switching center for purposes of cross-connecting smaller transmission facilities

and for regional maintenance advantages. From a hardware standpoint, the regional switching centers consist of a processor controlled digital switch which performs three primary functions. The first function is the PBX function. This function would process local calling between extensions, distributed smaller key systems and PBX's. All of the enhanced calling features would be available; such as call waiting, speed calling, call, queuing and camp-on, just to name a few. A second function of a regional switch would be to provide for tandem switching of calls from other regions to localities within the region. Besides inter-region calls, the regional switch would have the capability of least cost routing, which means a user simply dials the desired number and the switch determines the route that has the least cost. This capability is possible because of the processor controlled nature of the switch. The switch would also handle calls from and to the local telephone exchange and the linking of Wats lines to selected users. One feature of considerable importance is the queuing feature. This feature allows for a programmed delay in call connection when the least cost route is busy. When this route is available, the call will proceed. If after a certain delay the least cost route is not available, the call will proceed via an alternative route such as Wats or DDD network. Primary and alternate route selection would all be programmed into the switch initially and could be changed as conditions change. The third function of the regional switch is to provide SMDR functions. SMDR functions are defined as Station Message Detail Recording. This is basically a record of all calling activity which can be accounted for in terms of costs to the individual users. This feature would allow other governments and agencies to use the state network and receive a monthly bill detailing such usage. The new Dillon switch and PBX's planned for Helena, Bozeman, Missoula and Billings have the capabilities discussed.

The operation of the regional switching center can be summarized by stating that it interconnects the Local Area Network (LAN) to the local users of that network and to the other regional centers.

Exhibit 16, which is titled "Network Operation Diagram" shows a typical function of the regional center's operation. A telephone in Great Falls is connected through the network to a telephone from the Havre local state switch. Also a non-switched line providing a data link between Great Falls and Havre is shown. The primary difference between switched and non-switched lines is that non-switched lines enter the transmission system directly whereas switched lines always enter and/or exit through a switch such as a PBX, key system or Centrex.

Proposed Communications Network Technical Standards

The design of the proposed communications network, specifically the alternative transmission systems, was based on the quality standards applicable to the particular system. The present communications network meets Bell system transmission standards. The proposed network would also meet equivalent standards. Specifically the standards referred to are for channel noise performance, frequency response, cross talk, signaling quality, frequency stability and interface levels.

V. Comparison of Alternative Methods of Transmission

The comparison of selected transmission systems will allow a perspective of comparable costs and features; therefore, any future work on a state network can be more selective in its efforts. This study has analyzed microwave, fiber optics and satellite transmission systems. A discussion of each transmission method follows.

Microwave

Of the three technologies studied, microwave transmission is the oldest, best established and understood. The design, operation and reliability of such systems are well documented. As the technological advances have been made in the electronics industry; the quality, reliability and performance of microwave has steadily improved. Currently, one of the major trends is the application of digital technology to the transmission of the microwave signal.

All microwave systems were analog until the recent digital advances. There are three prime advantages offered by the new digital systems. The first is that more and more telephone equipment is becoming digital and the switching function is being performed digitally. There are thus potential cost savings when a digital transmission system is interfaced with a digital switching system. The interface standards have been developed. The second factor is that the cost of digital electronics has been dropping rapidly, making digital transmission facilities less expensive. One of the reasons for the lower cost is that handling bits is simpler than handling an analog signal and digital devices can be combined with other digital devices to a larger scale; therefore, production costs are lower. The third factor is that digital signals are regenerated rather than amplified like analog signals are. This offers an advantage because the regenerated signal is totally new and clean, whereas analog signals , when amplified, also amplify associated noise. As a practical advantage, when a digital source such as a computer utilizes a digital transmission system, the source signal does not require conversion to analog and the rather expensive modem can be eliminated and replaced with a relatively inexpensive interface unit.

One disadvantage of digital microwave has been that the smallest group of channels that could be dropped off was 24. However, companies such as Coastcom and Bayly Engineering have developed devices to drop off less than 24 channels economically. Digital microwave requires more sophisticated test equipment, but there are fewer adjustments and considerably less level setting compared to analog microwave. In general, digital RF equipment costs more than analog RF equipment, but the multiplex and channel equipment is considerably less; therefore, depending on the number of channels that are terminated, the total system cost for a digital system can be less despite higher RF costs. The proposed microwave transmission plan was priced for both a digital and an analog microwave. The cost difference can be identified specifically for the Montana system.

There are two main disadvantages of microwave in the State of Montana. First, although the electronics are quite reliable and hot standby is recommended, the atmospheric path is subject to fading. This means that under certain atmospheric conditions, the microwave signal can degrade to an unusable level. The design of the system must consider this factor in order to keep the outages to an acceptable level. An acceptable level would be considered 300 seconds per year of fading outage. The Plan II microwave design should meet these standards.

The second disadvantage is that microwave sites are usually located on high points. Quite often the high points are almost inaccessible during the extremes of Montana's weather. This means that additional transportation equipment, capable of handling mud and snow conditions, is necessary in order to perform required maintenance.

Two microwave network designs were considered in this study. Plan I is basically the plan developed for the state in 1973. Plan II was developed for this study. When the aforementioned system standards were applied to the Plan I design, it became apparent that this plan could not meet the standards. Although the sites are probably free of obstructions and should offer minimum site preparation work, the path links between sites are too long for a reliable quality signal. It would be unrealistic to replace the existing state network with a system offering less quality.

The 2 GHz band was chosen for the system design because it offered good propagation qualities and sufficient band width for the design. The analog microwave radios could be of the type offered by several manufacturers. The digital microwave radios are of a more current design. Both Farinon and Avantek offer 16 T-1 capacity radios in the 2 GHz industrial band. The design for all systems assumes hot standby operation. This offers superior link reliability and is required for the implementation of the regional switching center concept.

Exhibit 17 is a map of the Plan I proposed microwave system. Exhibit 18 is the Trunking Diagram for that Plan I system. Trunking diagrams were developed for all designs. They are required in order to determine required transmission facility capacity and to determine the quantity of circuits to be channelized. Exhibit 19 is the cost summary of the Plan I microwave system. Both analog and digital system costs have been developed. Exhibit 20 is a map of the Plan II microwave transmission system and Exhibit 21 is the Trunking Diagram for that system. Exhibit 22 is the associated cost summary for Plan II. Analog and digital microwave system costs have been also developed for Plan II. It should be remembered that Plan I does not offer the required circuit quality, and is, therefore, not comparable to any other plan.

Fiber Optics

The utilization of fiber optic technology for the transmission of communications has increased dramatically over the past three years. Many experimental applications have proven the feasibility and more recent applications have proven the cost effectiveness of this technology.

The results of considerable worldwide research and development efforts to improve signal sources and fiber quality is now apparent. These improvements are extending the economic length of systems to the point that it can be considered a viable technology for the State of Montana. There are several advantages of a fiber optics communications network. One advantage is that fibers are not sensitive to moisture and temperature as are other systems. Because the fiber is non-metallic, it can not be shorted and also is therefore immune to electrical interference. One primary advantage is the large bandwidth capability of fibers. This capability translates into large circuit capacity and high data transmission rates.

The main disadvantages of fiber optics is its difficulty to splice and installation of the cable in some areas can be very difficult. Also, although the price of light sources and fibers has dropped

at least 15% per year the last several years, the cost of repeater equipment is still quite high. The repeater equipment has to be powered from a local source because, unlike metallic transmission systems, power can not be carried with the cable. This results in the requirements for a battery supply and charging equipment, plus a local source of commercial power. Because advances in fiber optic technology are occuring so rapidly, the proposed fiber optic system design incorporates hardware which will not be available until 1983. There are many cost trade-offs in fiber optic system design. For example, by utilizing lower attenuation and/or more powerful light sources, repeater spacing is increased and, therefore, repeater quantities can be reduced. The trade-off is between the increased cost of cable and light sources compared to the cost savings obtained for the fewer repeaters required. These trade-offs were considered and are incorporated into the proposed fiber optic design.

The proposed fiber optic transmission design was based on a FST-2 system. In the digital hiarchy, this is a 6.3 MBIT system capable of 4 T-1 capacity, or 96 channels per fiber. A 20-mile spacing between repeaters was considered reasonable with long wavelength (1300 NM) multi-mode cable. Exhibits 23, 24 and 25 detail the proposed fiber optic system. Exhibit 24 is the trunking diagram and Exhibit 25 is a cost summary.

Satellite Network

The development of new satellite technology and the implementation of satellite communication systems has grown steadily since the first commercial communication satellite was put into service. Initially, only large common carriers, such as A.T. & T., could justify the cost of satellite usage. There has been a continual trend for decreasing costs. Many factors have contributed to this trend. Probably the most important factor has been advances in the satellite electronics which have increased the transmit power capabilities, signal reception and overall improvement of circuit quality. Considerable research and development efforts have resulted in very complex modulation, control and transmission techniques that

optimize the usage and capacity of the transponders. Some techniques optimize the type of transmission, such as data or voice and other modulation techniques optimize the simultaneous use of a transponder by many different users. These techniques are referred to as multiple-access. Because of the complexity of satellite transmission, a system approach is essential when considering applications. Potential vendors must be selected that can offer this approach.

It appears to be quite timely that there has been considerable development and interest in the needs of the smaller satellite system user. There are several small capacity, low cost systems available and some systems have just recently been announced. Because the primary application for the State of Montana network is voice communications, the following commercial systems were considered. The DYNAC System, the STARNET System and the SKYSWITCH System all could meet the requirements of the Montana network. These systems are optimized for the low capacity, low cost applications, such as the Montana Network. They all utilize specialized modulation and control techniques to enable many users to use a single transponder.

Costs for satellite transmission systems are composed of two parts: the ground segment and space segment. Exhibit 28 details the ground segment for the earth station hardware. The space segment cost is not an established industry figure. Usage requirements of less than a full transponder will cost considerably more per circuit than the former. Approximately $2,000 per month/percent of transponder usage is a realistic estimate. This projects $2.4 million per year for a full digital transponder. Analog transponders are less expensive to lease. When all factors are considered, a realistic estimate for transponder usage would be $700 per month per circuit. The State system would require 240 channels and would incur annual lease charges of $2,016,000. If capacity were available, the lease of a complete transponder could be considered.

Exhibits 26, 27 and 28 detail the proposed satellite system design. Exhibit 26 shows the Star Network design and Exhibit 27 shows the associated satellite system trunking diagram. The cost summary for the ground segment portion is tabulated in Exhibit 28.

Combined Technology Transmission System

The intent of the combined technology design is to optimize the application and cost advantages of each transmission technology. The design presented in Exhibit 29 is an optimized combination of all three technologies. The cost summary for the system is presented in three parts as Exhibit 30. An advantage of the combination design is that it particularly lends itself for development in phases on a regional basis.

Cost Summary - Alternative Transmission Methods

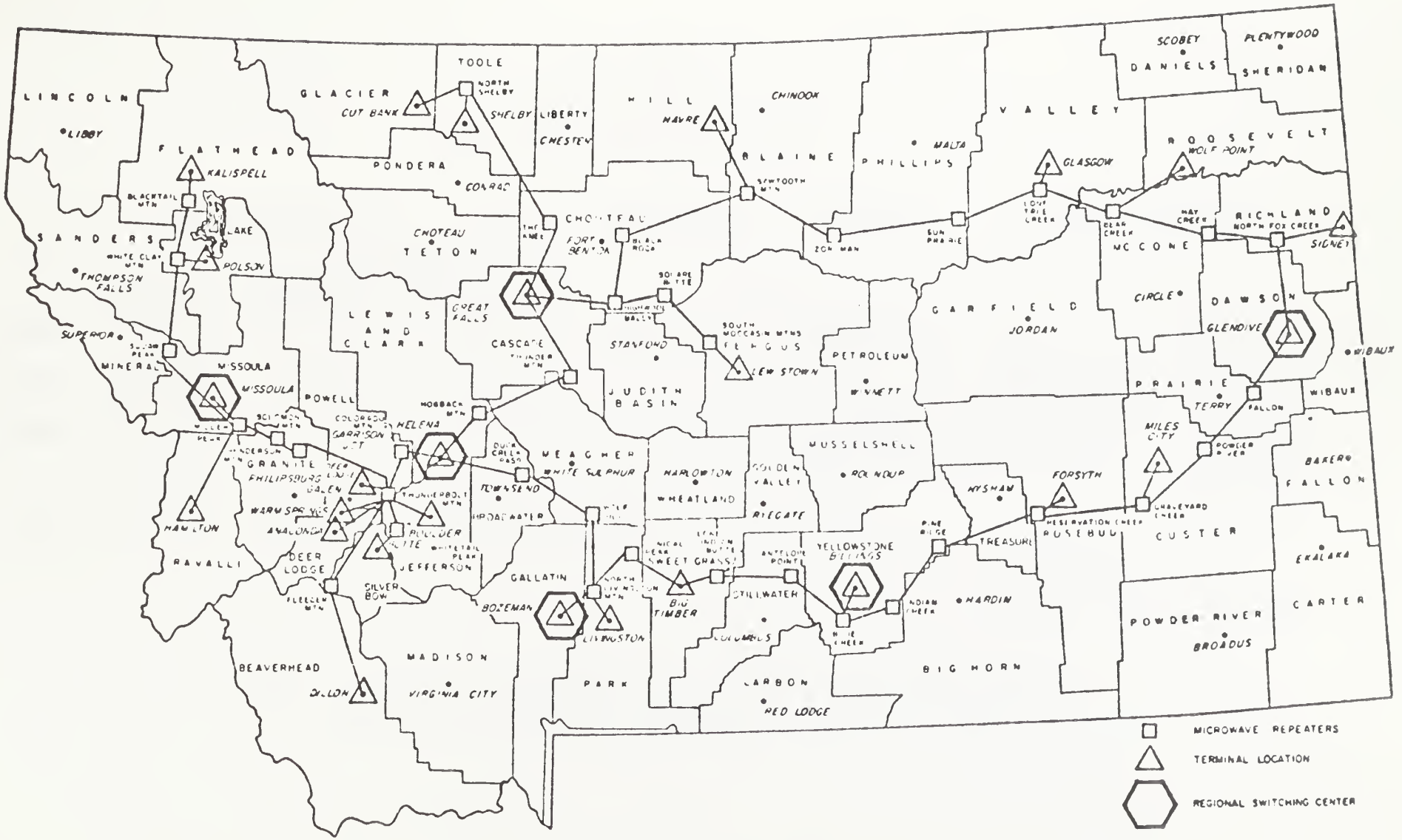
The costs of all alternative transmission systems considered are tabulated for comparison in Exhibit 31. As mentioned previously, Plan I was not considered technically compatible.

Recommendations

The State of Montana's telecommunication requirements are expected to grow considerably, primarily because of the advantages offered by improved communications between people and because of the emerging data handling environment. In order to meet these increases, a state-owned transmission system would offer several important advantages compared to the present system. First, a state network to the east and northeast regions of the state would be offered. This would increase the utility of all state users. Secondly, the state would have increased control over its communications costs and system configuration. Third, data transmission speed and quality would be improved. This feature will be of increasing importance as future data transmission needs are implemented. Fourth, the possibility of other government entities using, and therefore supporting the system, would offer increased utility to many users and cost advantages to the state.

After considering the many factors involved in an alternative transmission system, we recommend that the state requests competitive bids for a digital microwave system such as the proposed Plan II. The medium density digital microwave is recommended for maximum future capacity, particularly if video conferencing is a future possibility.

Digital microwave equipment is recommended as opposed to analog equipment because of the advantages discussed in the narrative.



STATE OF MONTANA
PROPOSED
MICROWAVE TRANSMISSION SYSTEM
PLAN II

COST SUMMARY

ALTERNATIVE TRANSMISSION METHODS

	Microwave Plant II			Fiber Optics	Satellite	Combined Methods	
		Digital					
	Analog	Low Density	Medium Density				
West	$ 3,683,200	$ 3,557,075	$ 3,826,175	$23,815,186	$9,400,500 Ground Segment + 2,016,000 Space Segment Lease	Fiber	$ 4,055,021
East	3,851,600	3,996,175	4,347,175			Satellite - Ground Segment	6,778,000
North	4,057,400	4,552,800	4,938,900			Microwave	1,313,250
Total	$11,592,200	$12,106,050	$13,112,250			Total	$12,146,271
						Satellite - Space Segment Lease	$ 2,016,000

NOTE: In addition to the above costs, estimated annual maintenance expenses of six percent of installed costs would be required.

EXHIBITS

STATE OF MONTANA

LIST OF EXHIBITS

Exhibit 1

1-1 Existing Telpak Routes

1-2 Telpak Channel Usage

Exhibit 2 Existing Telephone System Switch Information

Exhibit 3 Top Ten State Communications System Users

Exhibit 4 Departments and Field Office Description

Exhibit 5 Land/Mobile Radio System

5-1 Highway Department

5-2 State Lands Department (Forestry Div.)

5-3 Fish, Wildlife and Parks Department

5-4 Highway Patrol

5-5 Highway Patrol - Proposed Highband System

Exhibit 6 Selected Information Networks

Exhibit 7 Existing Data Communications Lines (Computer Services Division)

Exhibit 8 Future Data Communication Lines

Exhibit 9 Tie Lines and WATS Circuits, 1963-1982

Exhibit 10 Historical and Projected Growth of State Tie Lines and WATS Circuits - Graphic Illustrations

10-1 Helena Circuits

10-2 Billings and Boulder Circuits

10-3 Bozeman and Butte Circuits

10-4 Deer Lodge and Dillon Circuits

10-5 Great Falls and Havre Circuits

10-6 Kalispell Circuits

10-7 Miles City and Missoula Circuits

10-8 Warm Springs/Galen Circuits and Anaconda

Exhibit 11 Dedicated Lines - 1987

Exhibit 12 Circuit Termination Summary

12-1 1987 Quantities

12-2 1992 Quantities

12-3 1997 Quantities

Exhibit 13 Site Selection Analysis (3 pages)

Exhibit 14 Quantity of State Offices per Location (3 pages)

Exhibit 15 Regional Switching Areas

Exhibit 16 Network Operation Diagram

Exhibit 17 Proposed Microwave Transmission System, Plan I

Exhibit 18 Trunking Diagram - Microwave System, Plan I

Exhibit 19 Cost Summary - Microwave Plan I

19-1 Analog Microwave System

19-2 Digital Microwave System

Exhibit 20 Proposed Microwave Transmission, Plan II

Exhibit 21 Trunking Diagram - Microwave System, Plan II

Exhibit 22 Cost Summary - Microwave Plan II

22-1 Analog Microwave System

22-2 Digital Microwave System - Medium Density

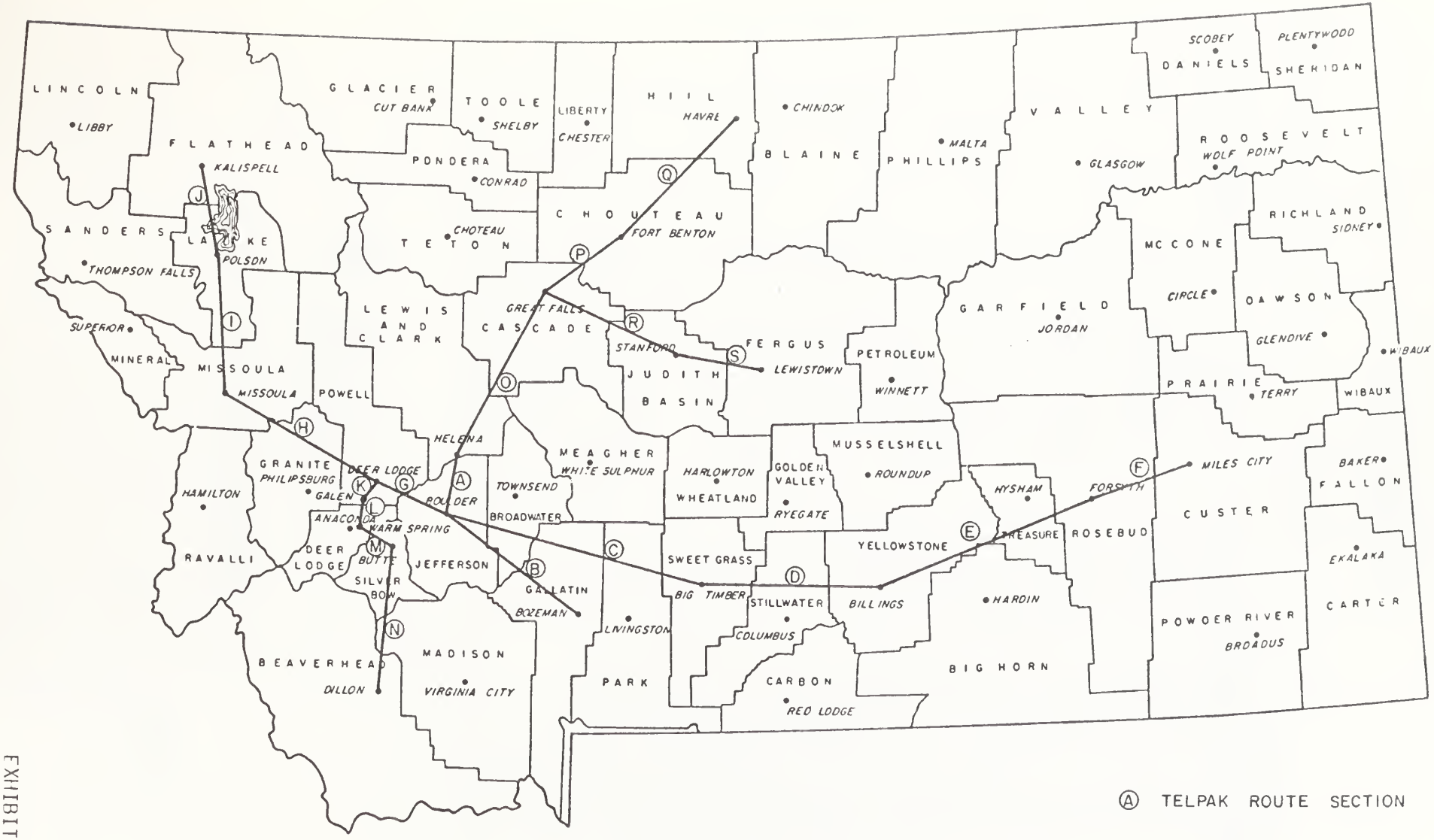
22-3 Digital Microwave System - Low Density

Exhibit 23 Proposed Fiber Optic Transmission System

Exhibit 24 Fiber Optic Transmission System, Trunking Diagram

Exhibit 25 Fiber Optic Transmission System, Cost Summary

Exhibit 26	Proposed Satellite Transmission System - Star Network Design
Exhibit 27	Proposed Satellite Transmission System - Trunking Diagram
Exhibit 28	Cost Summary - Satellite System
Exhibit 29	Proposed Transmission System - Combined Technology
Exhibit 30	Cost Summary - Combined Technology System
Exhibit 31	Cost Summary - Alternative Transmission Methods
Appendix A	List of Departments and Locations of Field Offices



Ⓐ TELPAK ROUTE SECTION

EXHIBIT 1-1

EXHIBIT 1-1

STATE OF MONTANA

EXISTING TELPAK ROUTES

STATE OF MONTANA

TELPAK CHANNEL USAGE

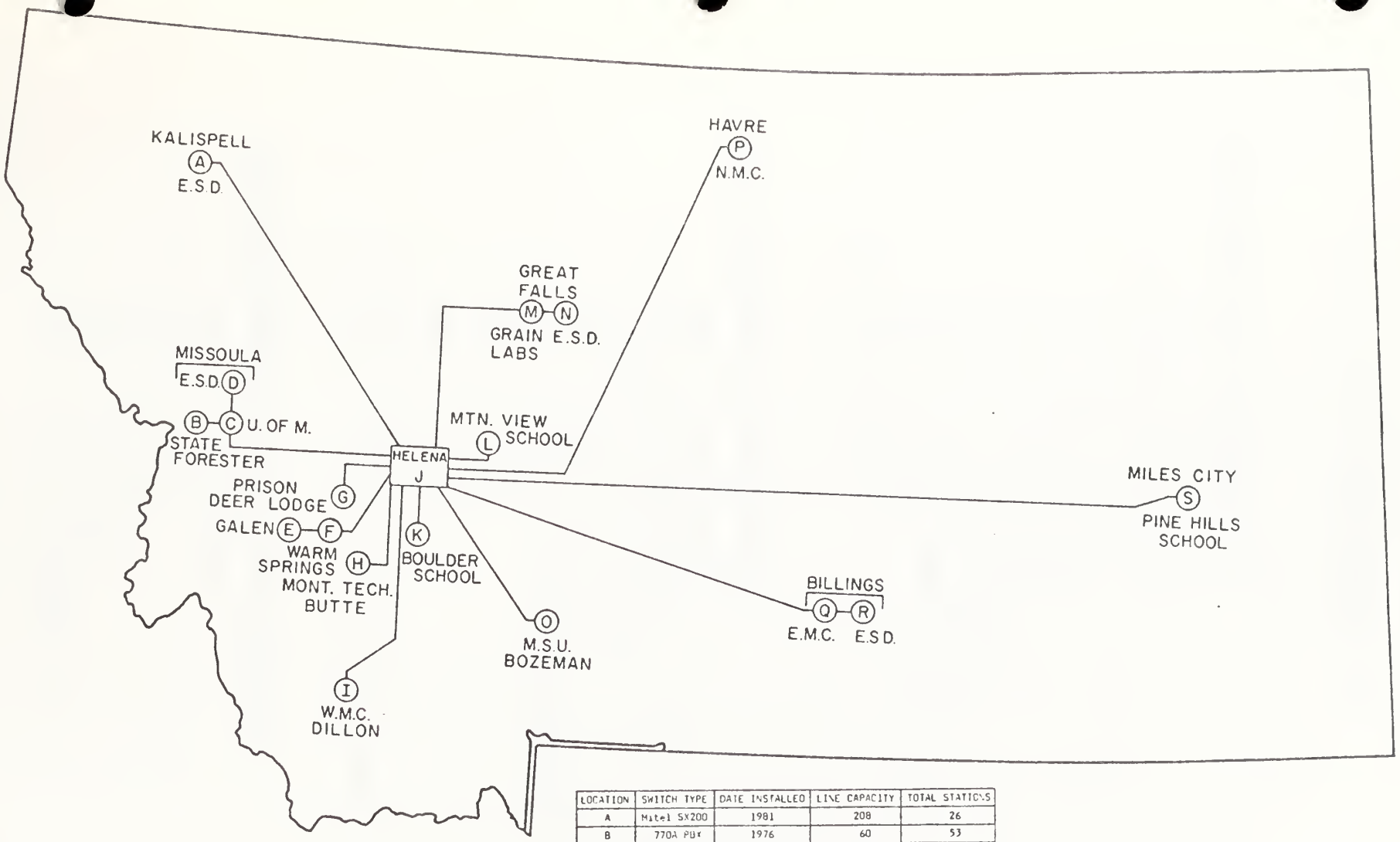
June, 1982

Air Mileage	Map Location	Line	Capacity	Network (VN)	DEDICATED Voice (VT)	DEDICATED Data VG	DEDICATED Data DG	Idle
26	A	Helena-Boulder	240	152	11	23	3	51
65	B	Boulder-Bozeman	60	26	10	8	1	15
108	C	Boulder-Big Timber	60	39	4	5	1	11
70	D	Big Timber-Billings	60	39	4	5	1	11
96	E	Billings-Forsyth	24	11	1	-	1	11
41	F	Forsyth-Miles City	24	11	1	-	1	11
32	G	Boulder-Deer Lodge	240	82	2	13	2	141
69	H	Deer Lodge-Missoula	60	43	2	6	2	7
58	I	Missoula-Polson	24	10	-	2	1	11
36	J	Polson-Kalispell	24	10	-	2	1	11
16	K	Deer Lodge-Galen	60	32	2	8	1	17
4	L	Galen-Warm Springs	60	34	2	8	1	15
19	M	Warm Springs-Butte	60	27	1	8	1	23
55	N	Butte-Dillon	12	5	1	2	1	3
72	O	Helena-Great Falls	60	29	2	4	2	23
37	P	Great Falls-Ft. Benton	12	9	1	2	1	-1
69	Q	Ft. Benton-Havre	12	9	1	2	1	-1
56	R	Great Falls-Stanford	12	-	4	2	1	5
38	S	Stanford-Lewistown	12	-	4	2	1	5

DDG = Data Data Grade
DDV = Data Voice Grade
VT = Voice Transmission
VN = Voice Network

VT = FX's, Teleconferencing
VN = State Private Line SW Network

EXHIBIT 1-2



LOCATION	SWITCH TYPE	DATE INSTALLED	LINE CAPACITY	TOTAL STATIONS
A	Mitel SX200	1981	208	26
B	770A PBX	1976	60	53
C	NCX23 CTX	1971	3,200	2,684
D	770A PBX	1976	80	37
E	770A PBX	1977	160	109
F	770A PBX	1975	200	264
G	770A PBX	1977	120	134
H	D400 FP4	1980	380	282
I	S-C DBX1200	1982	600	408
J	NTI SL-1	1982	Trunk Sw.	
J	#5 XBAR CTX	1969	2,938	3,678
K	757 PBX	1970	160	197
L	756 PBX	1970	60	32
M	740E PBX	1968	55	54
N	770A PBX	1977	120	52
O	701 CTX	1971	2,940	2,677
P	770A PBX	1977	200	70
Q	701 CTX	1966	1,000	861
R	770A PBX	1972	80	78
S	770A PBX	1978	100	62

EXHIBIT 2

STATE OF MONTANA

EXISTING TELEPHONE SYSTEM
SWITCH INFORMATION

STATE OF MONTANA

TOP TEN STATE COMMUNICATIONS
SYSTEM USERS

LONG DISTANCE USERS (W/UNIVERSITIES)

1. Dept. of Administration
2. Montana State University
3. University of Montana
4. Fish, Wildlife and Parks
5. Eastern Montana College
6. Office of Public Instruction
7. Dept. of Labor and Industry
8. Dept. of Social & Rehabilitation Services
9. Dept. of Revenue
10. Montana Tech

LONG DISTANCE USERS (W/O UNIVERSITIES)

1. Dept. of Administration
2. Fish, Wildlife and Parks
3. Office of Public Instruction
4. Dept. of Labor and Industry
5. Dept. of Social & Rehabilitation Services
6. Dept. of Revenue
7. Dept. of Highways
8. Dept. of Commerce
9. Dept. of Justice
10. Dept. of Natural Resources & Conservation

LEASED LINE (DEDICATED) SERVICE (W/O UNIVERSITIES)

1. Dept. of Administration
2. Dept. of Justice
3. Dept. of Highways
4. Dept. of Agriculture
5. Dept. of Labor and Industry

6. Commissioner of Higher Education
7. Office of Public Instruction
8. Adjutant General
9. Dept. of Institutions
10. Dept. of Social & Rehabilitation Services

STS USAGE (W/O UNIVERSITIES)

1. Dept. of Social & Rehabilitation Services
2. Dept. of Highways
3. Dept. of Labor and Industry
4. Dept. of Revenue
5. Dept. of Fish, Wildlife and Parks
6. Health and Environmental Sciences
7. Dept. of Natural Resources and Conservation
8. Dept. of Institutions
9. Dept. of Justice
10. Dept. of Administration

TOTAL USAGE (LEASED LINES, LONG DISTANCE, DATA LINES AND STS) - W/O UNIVERSITIES

1. Dept. of Administration
2. Dept. of Justice
3. Dept. of Social & Rehabilitation Services
4. Dept. of Labor and Industry
5. Dept. of Highways
6. Dept. of Fish, Wildlife and Parks
7. Dept. of Revenue
8. Dept. of Natural Resources and Conversation
9. Dept. of Commerce
10. Dept. of Institutions

STATE OF MONTANA

DEPARTMENTS AND FIELD OFFICE DESCRIPTION

Department	Number of Field Offices	Field Offices - Description
Administration	-	
Agriculture	24	12 Specialized 12 Ag. Experiment Stations
Auditor	-	
Commerce	1	1 Bd. of Pharmacists-G. Falls
Education	2	2 School for Deaf & Blind-G. Falls Mt. Historical Soc.-Libby
Fish, Wildlife & Parks	70	5 Offices 48 Game Warden Offices 17 Game Ranges, Fish Hatcheries, etc.
Governor's Office	1	1 Legal Jurisdiction Proj.-Missoula
Health	6	6 Offices
Highways	127	11 Division Offices 92 Maintenance Shops/Garages 21 Weigh Stations 3 Miscellaneous
Institutions	64	35 Mental Health Centers 17 Community Corrections Bureaus 9 Facilities 3 Miscellaneous
Justice	19	7 Highway Patrol Offices 4 Board of Crime Control 4 Fire Marshall Bureaus 4 Miscellaneous
Labor & Industry	25	24 Job Service Offices 1 Miscellaneous
State Lands	14	12 Forestry Division Offices 2 Miscellaneous

Department	Number of Field Offices	Field Offices - Description
Livestock	30	16 Brand Inspection Offices 8 District Vets 4 Milk & Egg Bureau 1 Miscellaneous
Library	-	
Legislative Branch	-	
Lieutenant Governor	-	
Military Affairs	39	28 Guard Companies 5 D.E.S. Offices 6 Organizational Maintenance Shop
Natural Resources	14	4 Oil and Gas Conserv. District 7 Water Rights Bureaus 3 Miscellaneous
Revenue	141	55 County Appraiser/County Assessor 4 Child Support Enforce. Bureau 2 Income Tax Div. Offices 6 Investigations Offices 74 Liquor Stores
Office of Public Inst.	-	
Public Service Regulation	-	
Secretary of State	-	
Social & Rehab. Svcs.	21	21 Offices
Supreme Court	-	
University System	8	6 Colleges/Universities 2 Other
Miscellaneous	12	
TOTAL	617	

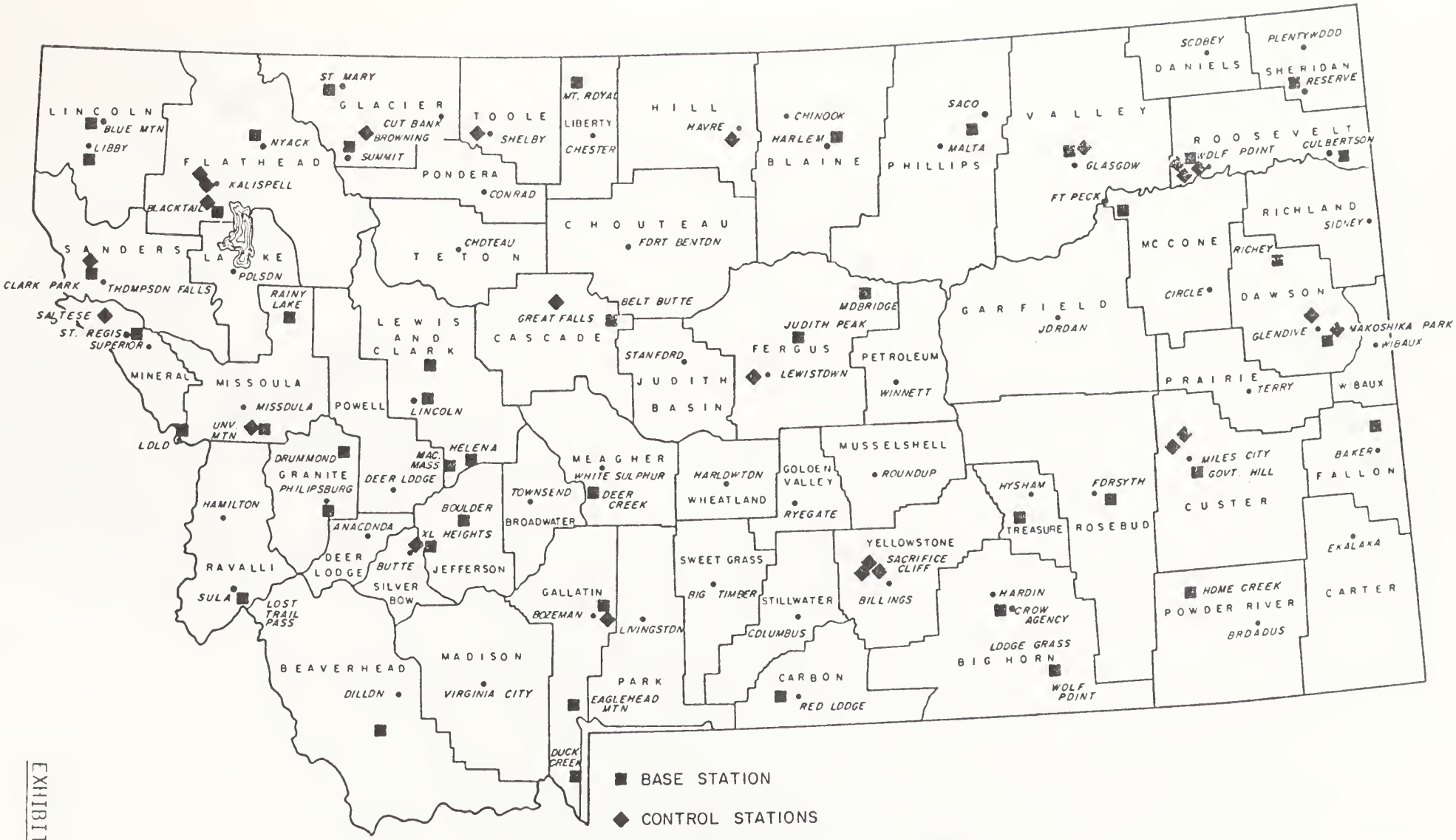


EXHIBIT 5-1

EXHIBIT 5-1

STATE OF MONTANA
LAND/MOBILE RADIO SYSTEM

HIGHWAY DEPARTMENT

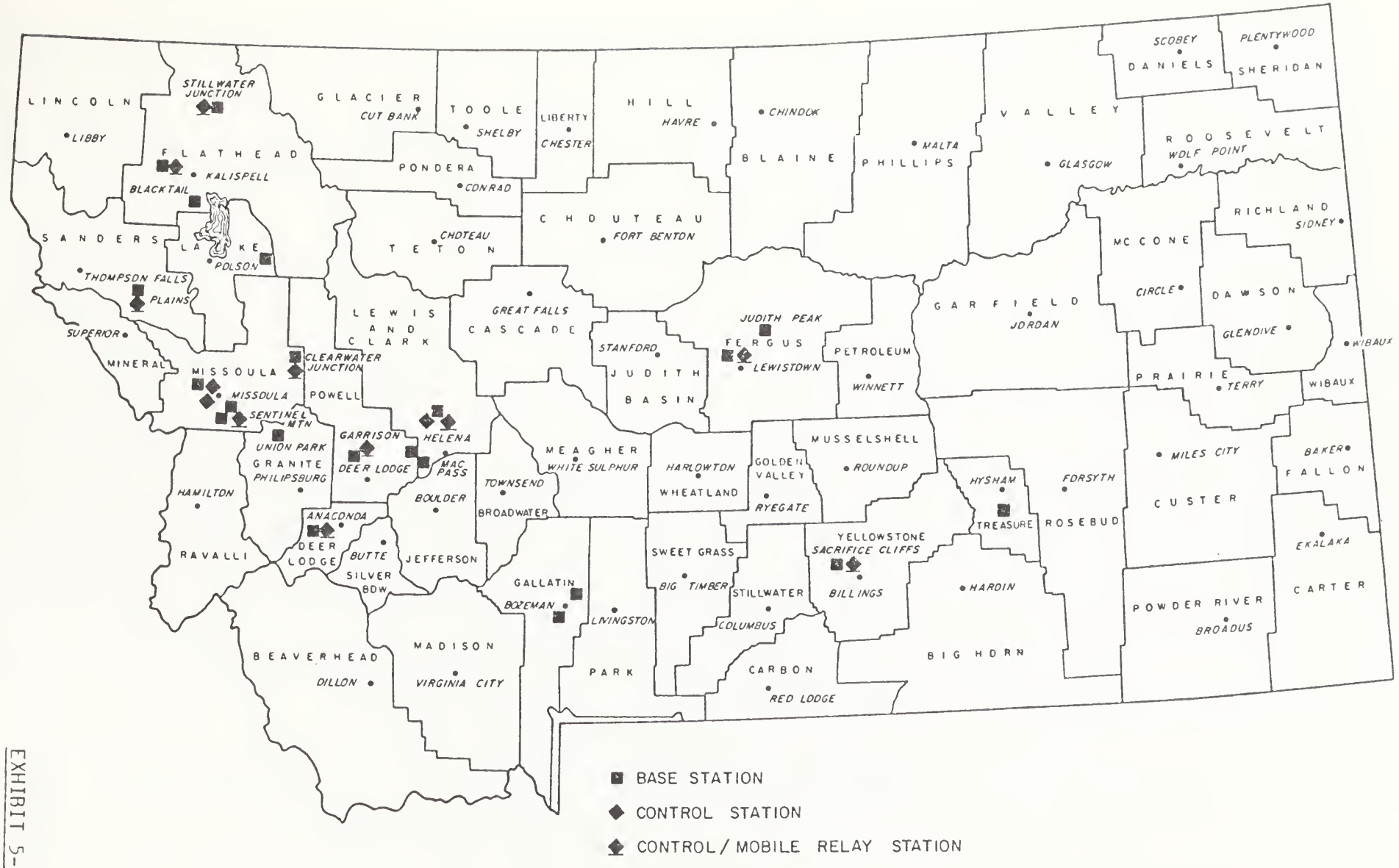


EXHIBIT 5-2

EXHIBIT 5-2

STATE OF MONTANA
LAND / MOBILE RADIO SYSTEM
STATE LANDS DEPT.
(FORESTRY DIV.)

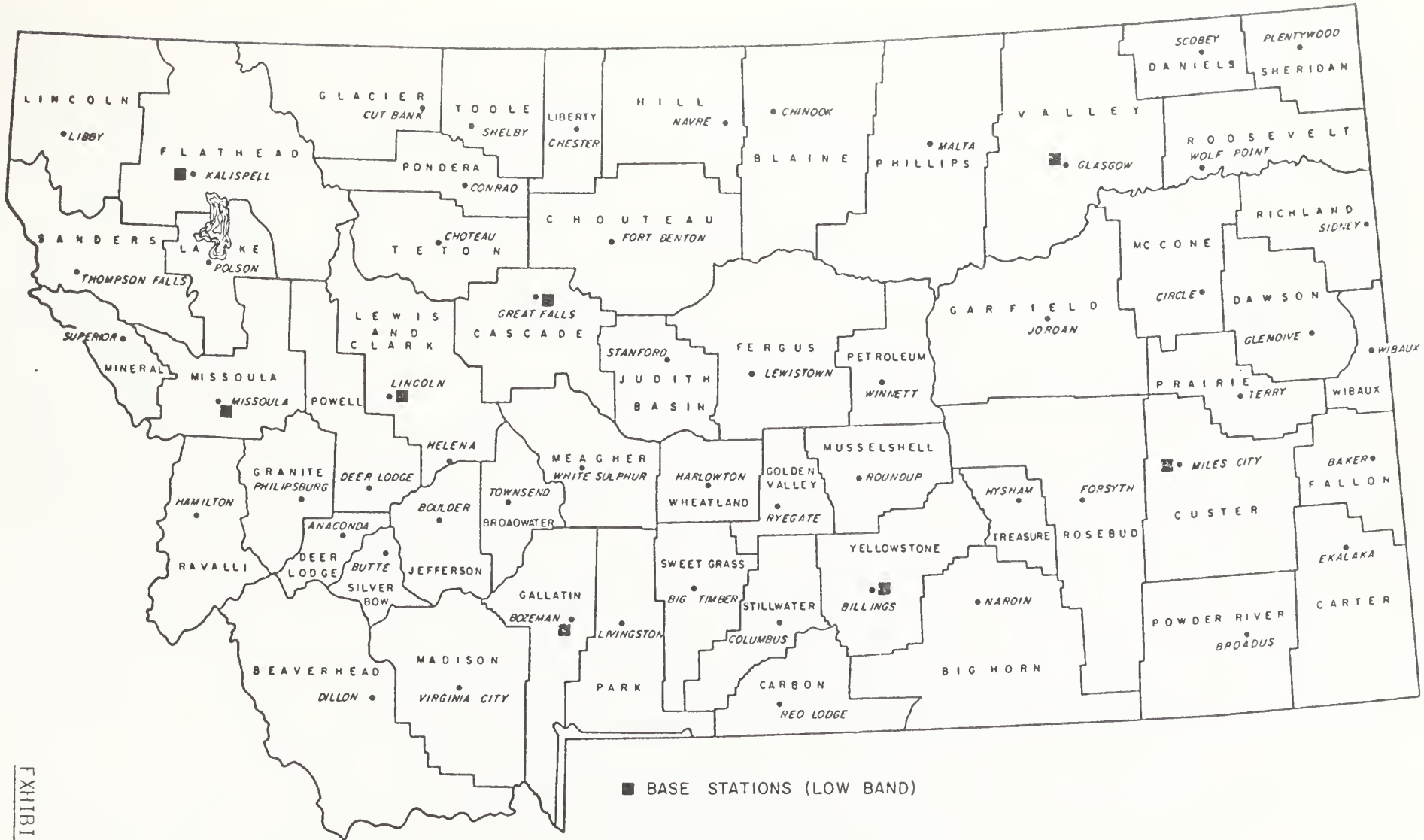


EXHIBIT 5-3

EXHIBIT 5-3

STATE OF MONTANA
LAND / MOBILE RADIO SYSTEM
FISH, WILDLIFE & PARKS
DEPARTMENT

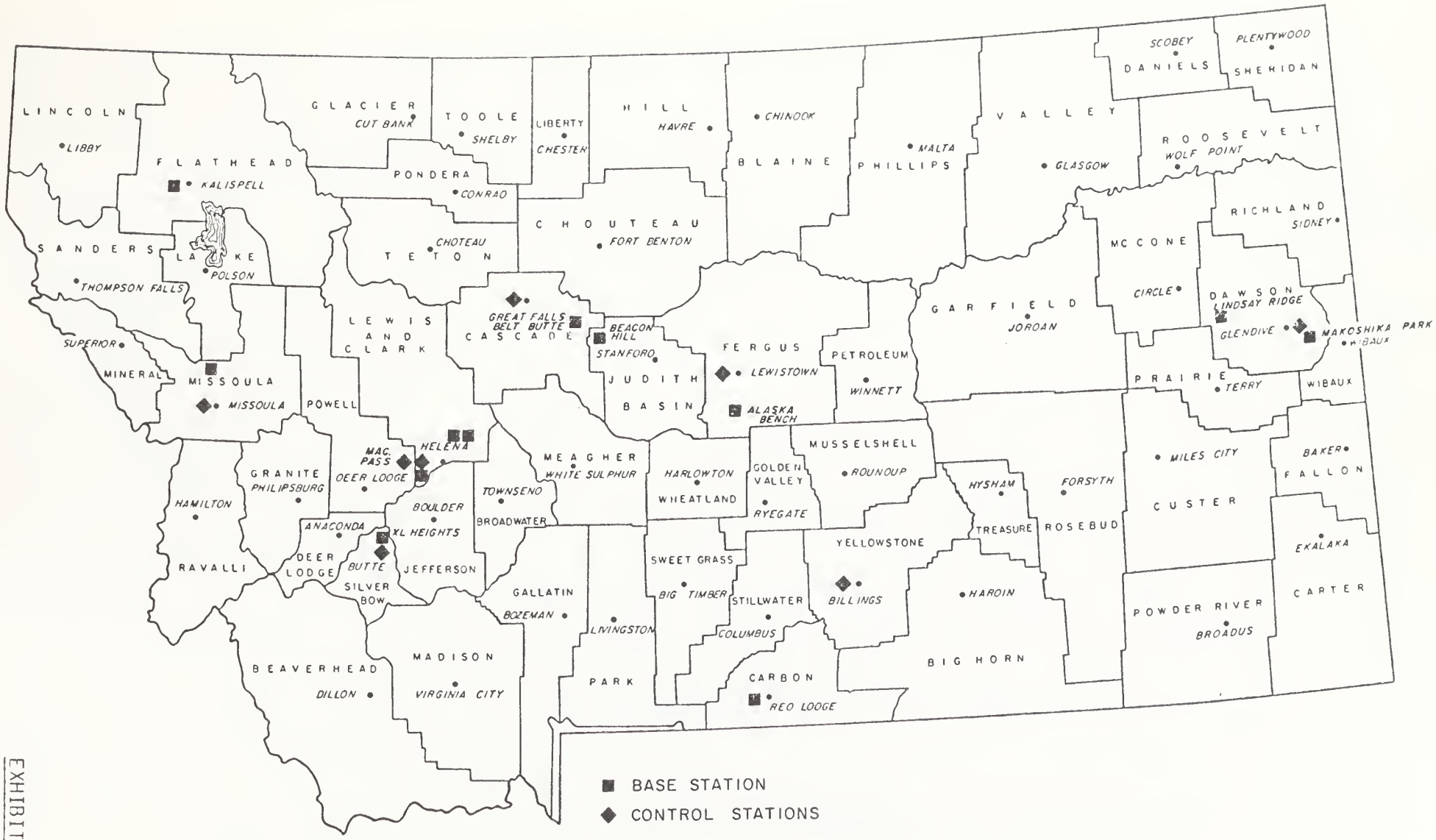


EXHIBIT 5-4

EXHIBIT 5-4

STATE OF MONTANA
LAND / MOBILE RADIO SYSTEM

HIGHWAY PATROL

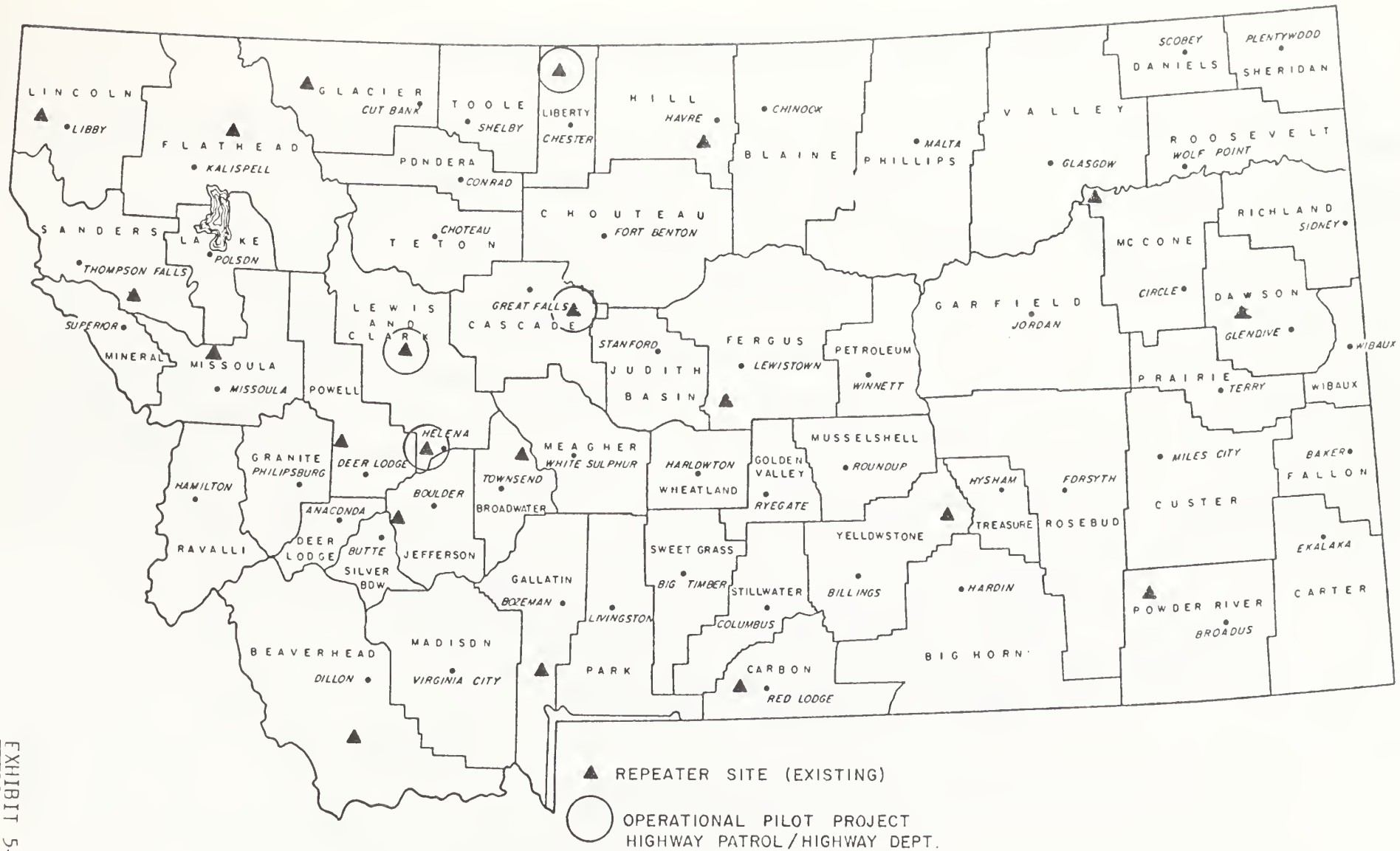


EXHIBIT 5-5

EXHIBIT 5-5

STATE OF MONTANA
PROPOSED HIGHBAND
LAND/MOBILE RADIO SYSTEM

HIGHWAY PATROL

SELECTED INFORMATION NETWORKS

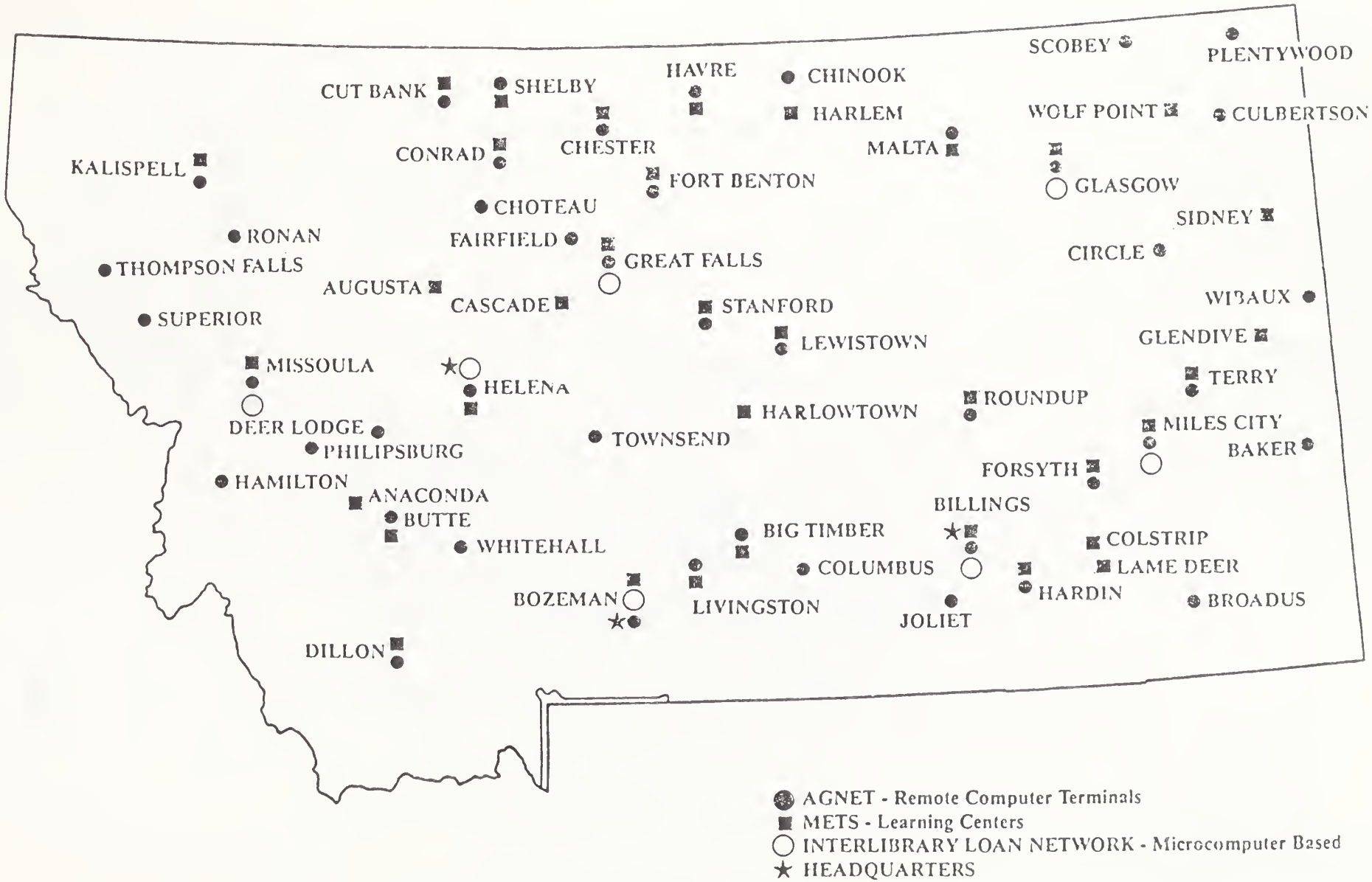


EXHIBIT 6

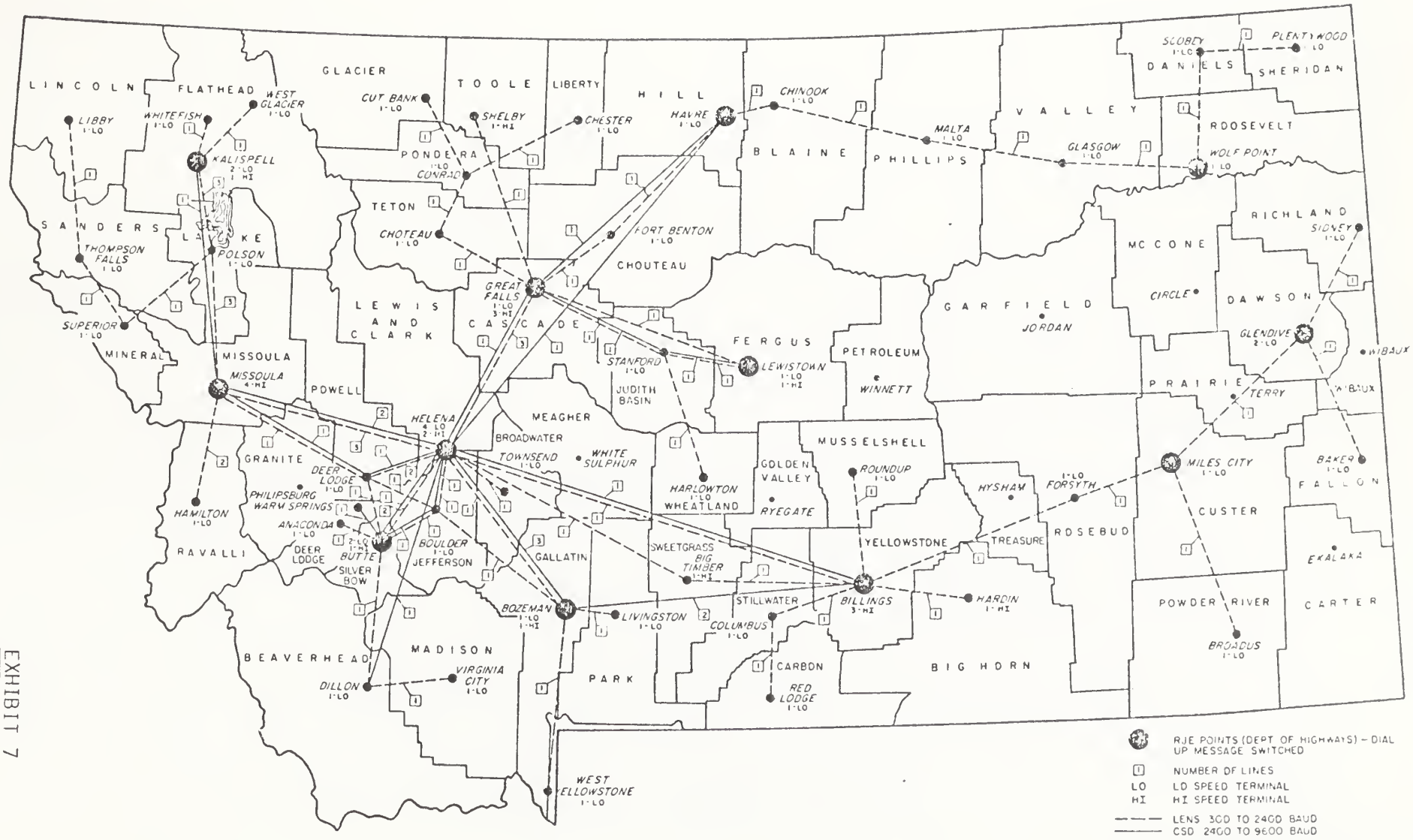
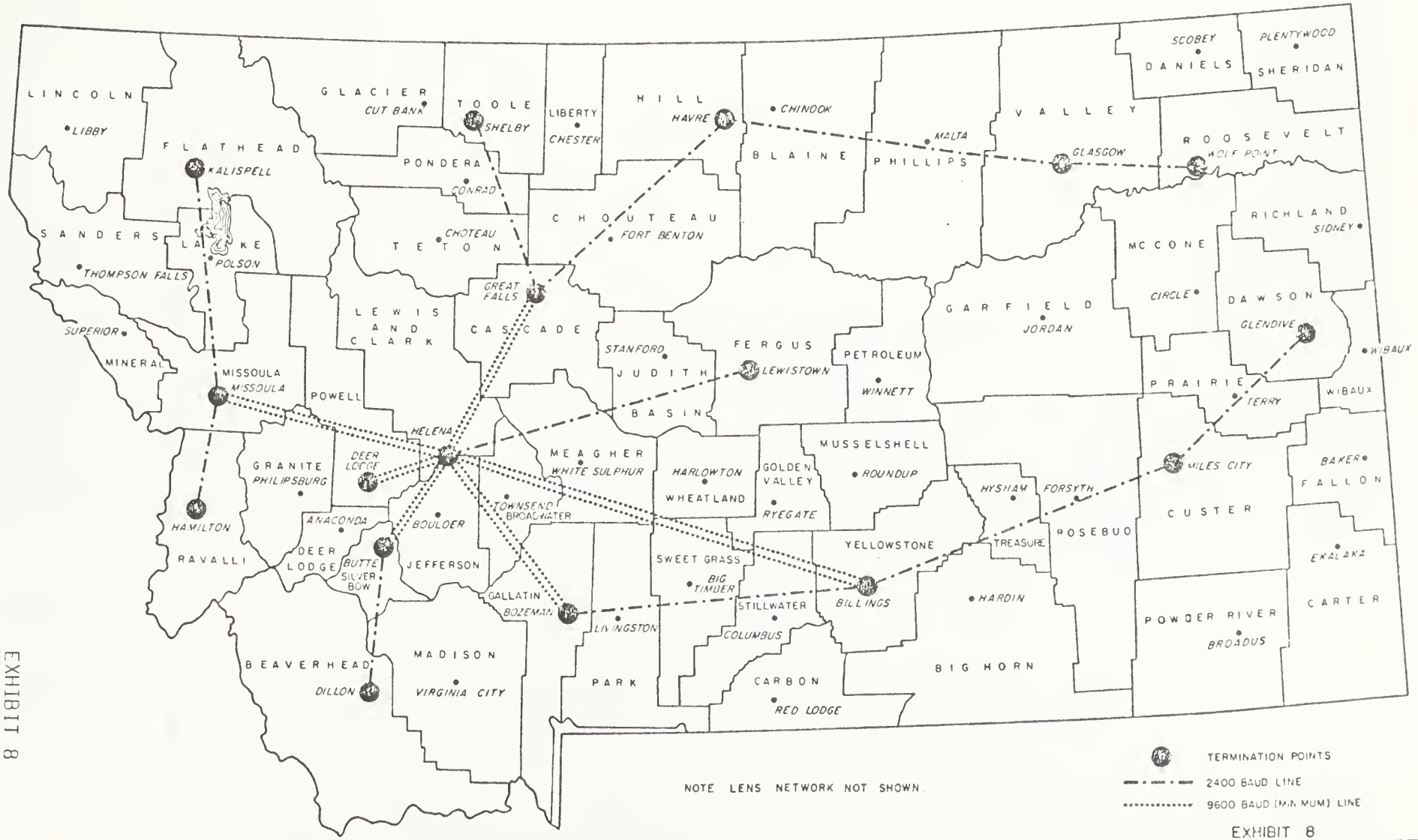


EXHIBIT 7

EXHIBIT 7

STATE OF MONTANA

EXISTING DATA COMMUNICATIONS LINES
(COMPUTER SERVICES DIVISION)



NOTE LENS NETWORK NOT SHOWN.

EXHIBIT 8

EXHIBIT 8

STATE OF MONTANA

COMPUTER SERVICES DIVISION
FUTURE DATA COMMUNICATION LINES

TIE LINES AND WATS CIRCUITS

Helena To:	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Billings	3	3	4	4	5	6	8	8	10	12	14	18	18	21	21	21	25	28	28	28
Boulder							1	1	2	3	3	3	4	6	6	6	5	5	5	5
Bozeman	3	3	4	5	6	7	9	9	12	12	12	16	17	18	18	18	20	26	26	26
Butte		2	3	3	3	3	4	5	7	10	10	11	11	12	12	12	12	17	19	19
Deer Lodge							2	2	3	3	3	3	4	5	5	5	5	7	7	7
Dillon															3	3	3	4	5	5
Great Falls	3	3	4	4	5	6	8	8	8	10	11	12	14	16	14	14	14	19	20	20
Havre										3	3	4	4	6	6	6	6	8	9	9
Kalispell									3	3	4	5	5	7	7	7	8	10	10	10
Miles City						2	2	3	4	4	6	6	6	7	7	7	10	10	11	11
Missoula	3	3	4	5	6	7	9	9	9	12	17	22	22	24	24	24	30	33	33	33
Warm Springs (Anaconda)							3	3	3	5	6	7	7	7	7	7	7	7	8	8
Warm Springs to Galen							1	1	1	1	1	1	1	2	2	2	2	2	2	2
Total Tie Lines	12	14	19	21	25	31	47	49	62	78	90	108	113	131	132	132	147	176	183	183
WATS Lines	3	6	9	11	12	13	15	15	18	20	20	19	20	25	27	27	28	34	35	35
Total STS Circuits	15	20	28	32	37	44	62	64	80	98	110	127	133	156	159	159	175	210	218	218

EXHIBIT 9

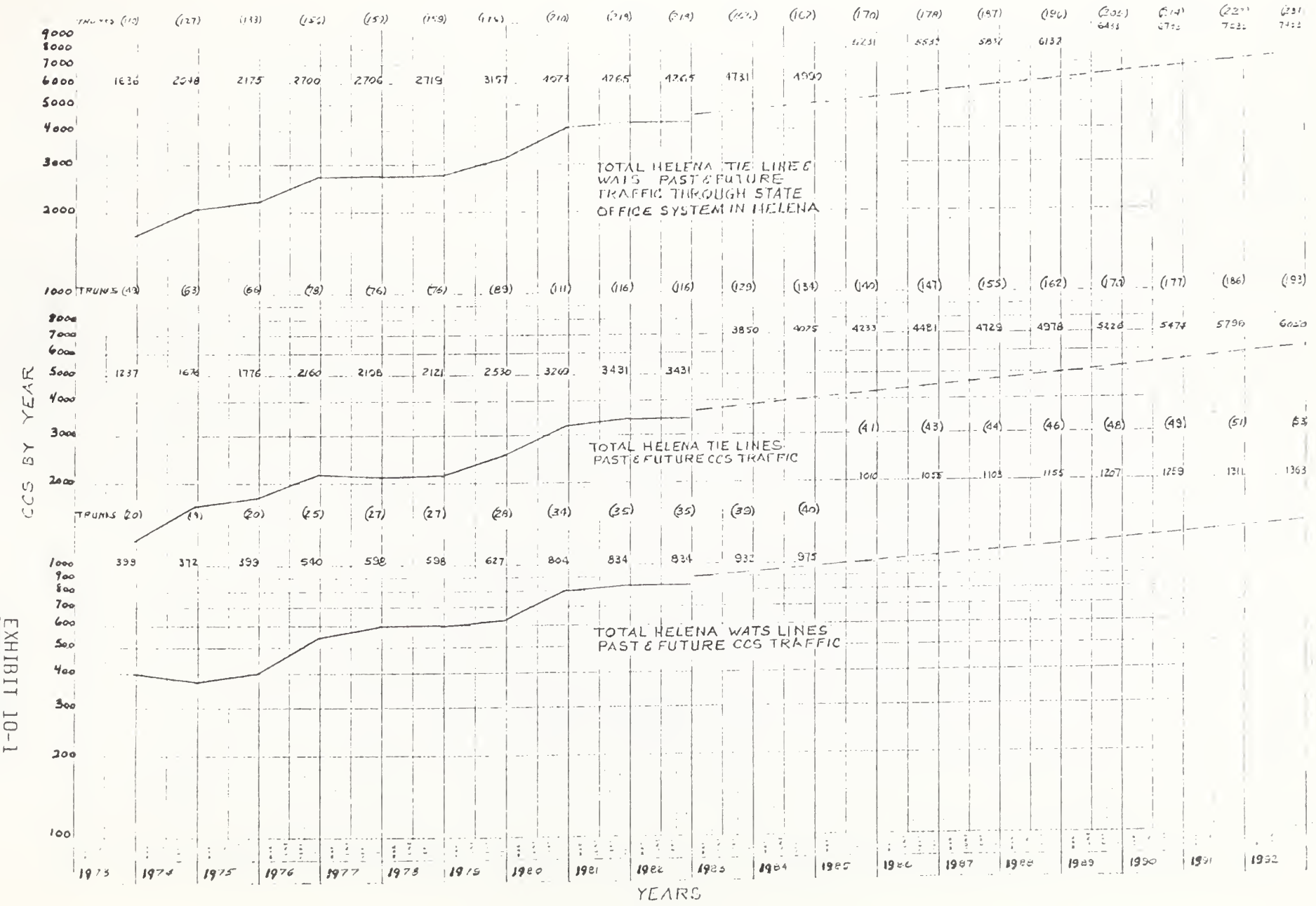

TOTAL HELENA TIE LINE & WATS PAST & FUTURE TRAFFIC THROUGH STATE OFFICE SYSTEM IN HELENA
TOTAL HELENA TIE LINES PAST & FUTURE CCS TRAFFIC
TOTAL HELENA WATS LINES PAST & FUTURE CCS TRAFFIC
CCS BY YEAR
YEARS
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992

EXHIBIT 10-1

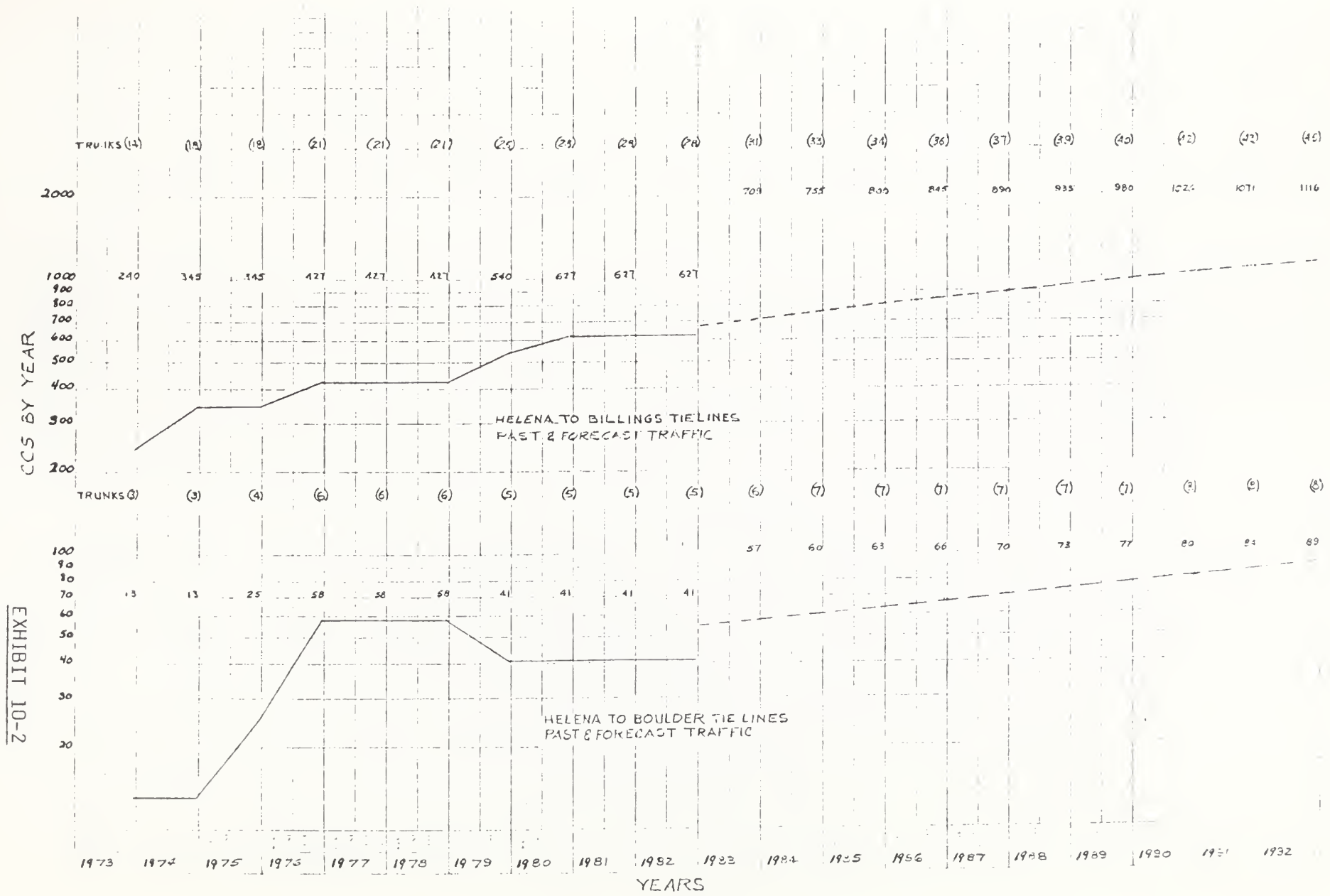

TRUNKS (14) (18) (18) (21) (21) (21) (25) (25) (24) (24) (31) (33) (34) (36) (37) (39) (40) (42) (42) (45)
709 755 800 845 890 935 980 1026 1071 1116
2000
1000
900
800
700
600
500
400
300
200
240 345 345 427 427 427 540 627 627 627
CCS BY YEAR
HELENA TO BILLINGS TIE LINES
PAST & FORECAST TRAFFIC
TRUNKS (3) (3) (4) (5) (6) (6) (5) (5) (5) (5) (6) (7) (7) (7) (7) (7) (7) (8) (8) (8)
57 60 63 66 70 73 77 80 84 89
100
90
80
70
60
50
40
30
20
13 13 25 58 58 58 41 41 41 41
HELENA TO BOULDER TIE LINES
PAST & FORECAST TRAFFIC
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-2

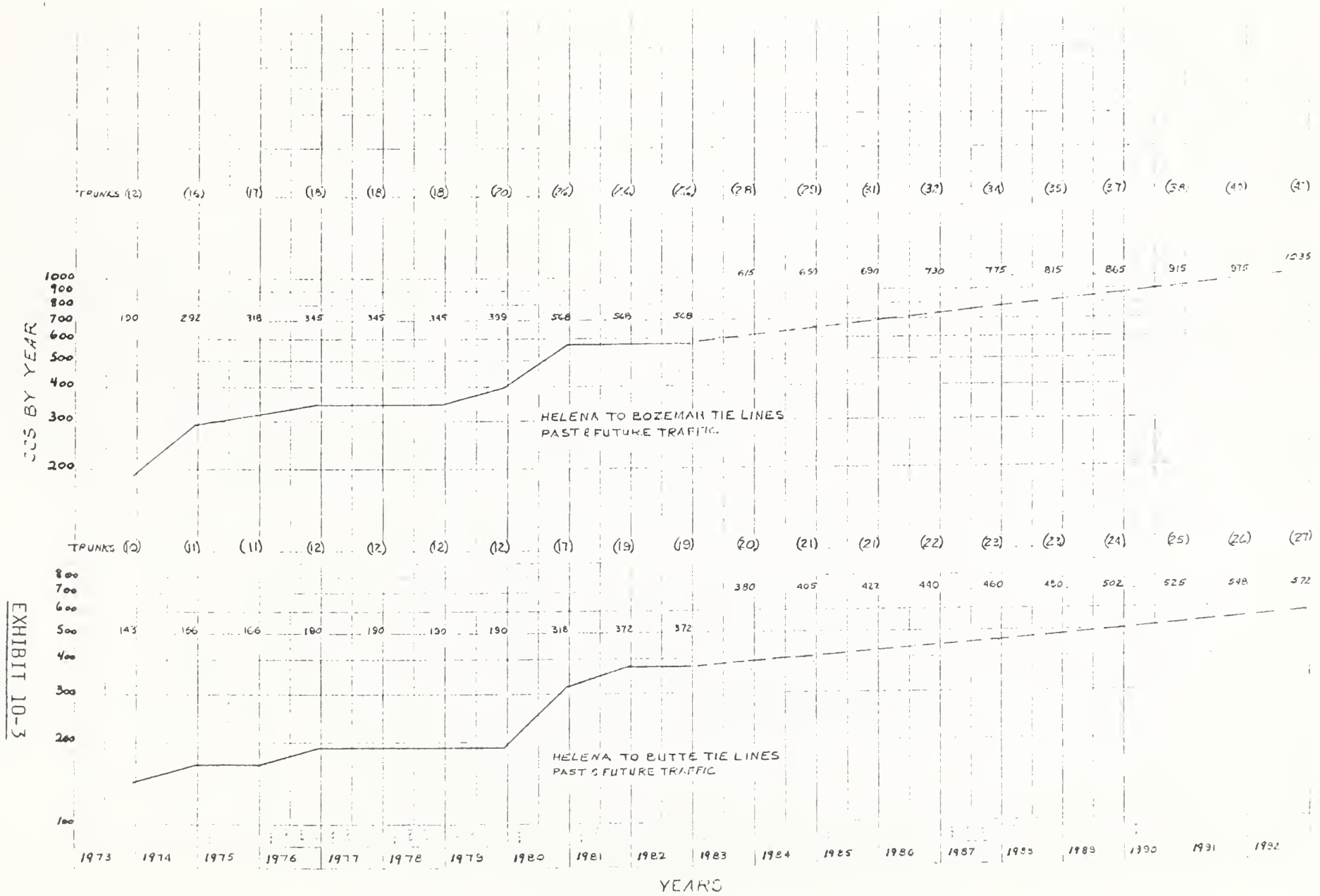

TRUNKS (12) (16) (17) (18) (18) (18) (20) (24) (24) (24) (28) (29) (31) (32) (34) (35) (37) (38) (40) (41)
1000
900
800
700
600
500
400
300
200
CCS BY YEAR
190 292 318 345 345 345 399 568 568 568 615 653 690 730 775 815 865 915 975 1035
HELENA TO BOZEMAN TIE LINES
PAST & FUTURE TRAFFIC
TRUNKS (10) (11) (11) (12) (12) (12) (12) (17) (19) (19) (20) (21) (21) (22) (23) (23) (24) (25) (26) (27)
800
700
600
500
400
300
200
100
143 166 166 180 190 130 190 318 372 372 380 405 422 440 460 480 502 525 548 572
HELENA TO BUTTE TIE LINES
PAST & FUTURE TRAFFIC
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-3

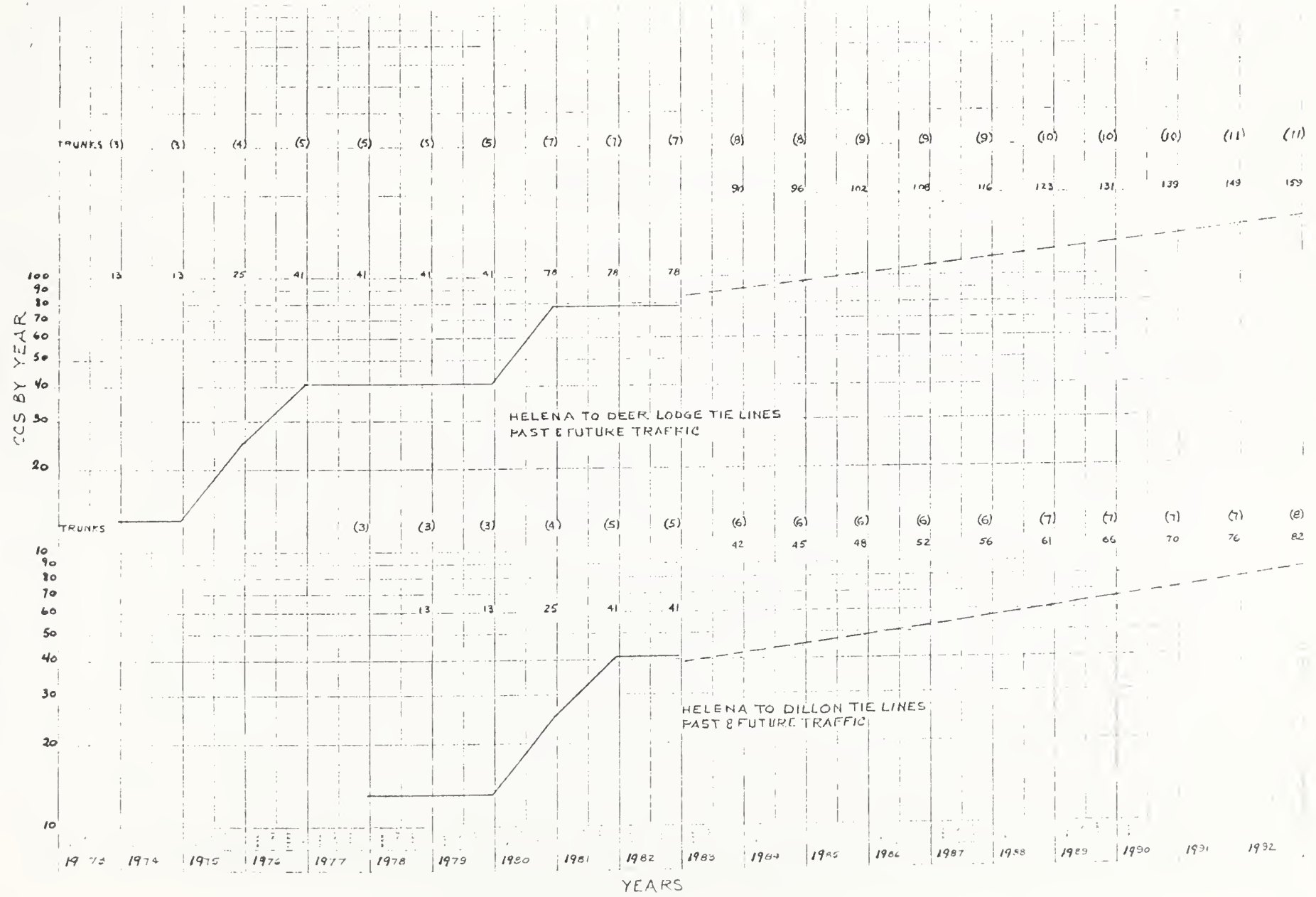

TRUNKS (3) (3) (4) (5) (5) (5) (5) (7) (7) (7) (8) (8) (9) (9) (9) (10) (10) (10) (11) (11)
90 96 102 108 116 123 131 139 149 159
100 13 13 25 41 41 41 41 78 78 78
90
80
70
60
50
40
30
20
CCS BY YEAR
HELENA TO DEER LODGE TIE LINES
PAST & FUTURE TRAFFIC
TRUNKS (3) (3) (3) (4) (5) (5) (6) (6) (6) (6) (6) (7) (7) (7) (7) (8)
42 45 48 52 56 61 66 70 76 82
10
90
80
70
60
50
40
30
20
13 13 25 41 41
HELENA TO DILLON TIE LINES
PAST & FUTURE TRAFFIC
10
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-4

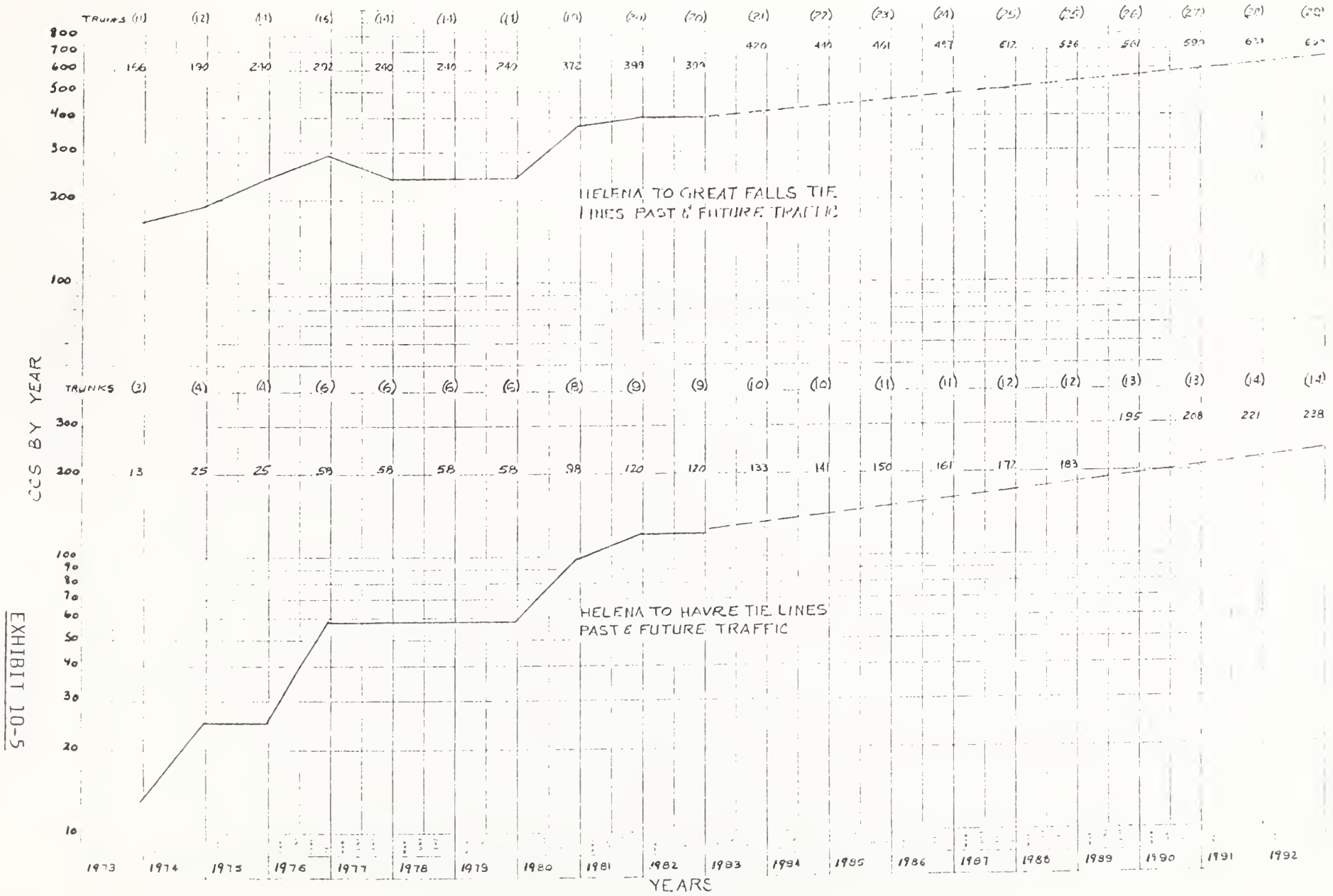

HELENA TO GREAT FALLS TIE LINES PAST & FUTURE TRAFFIC
HELENA TO HAVRE TIE LINES PAST & FUTURE TRAFFIC
CCS BY YEAR
YEARS
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992

EXHIBIT 10-5

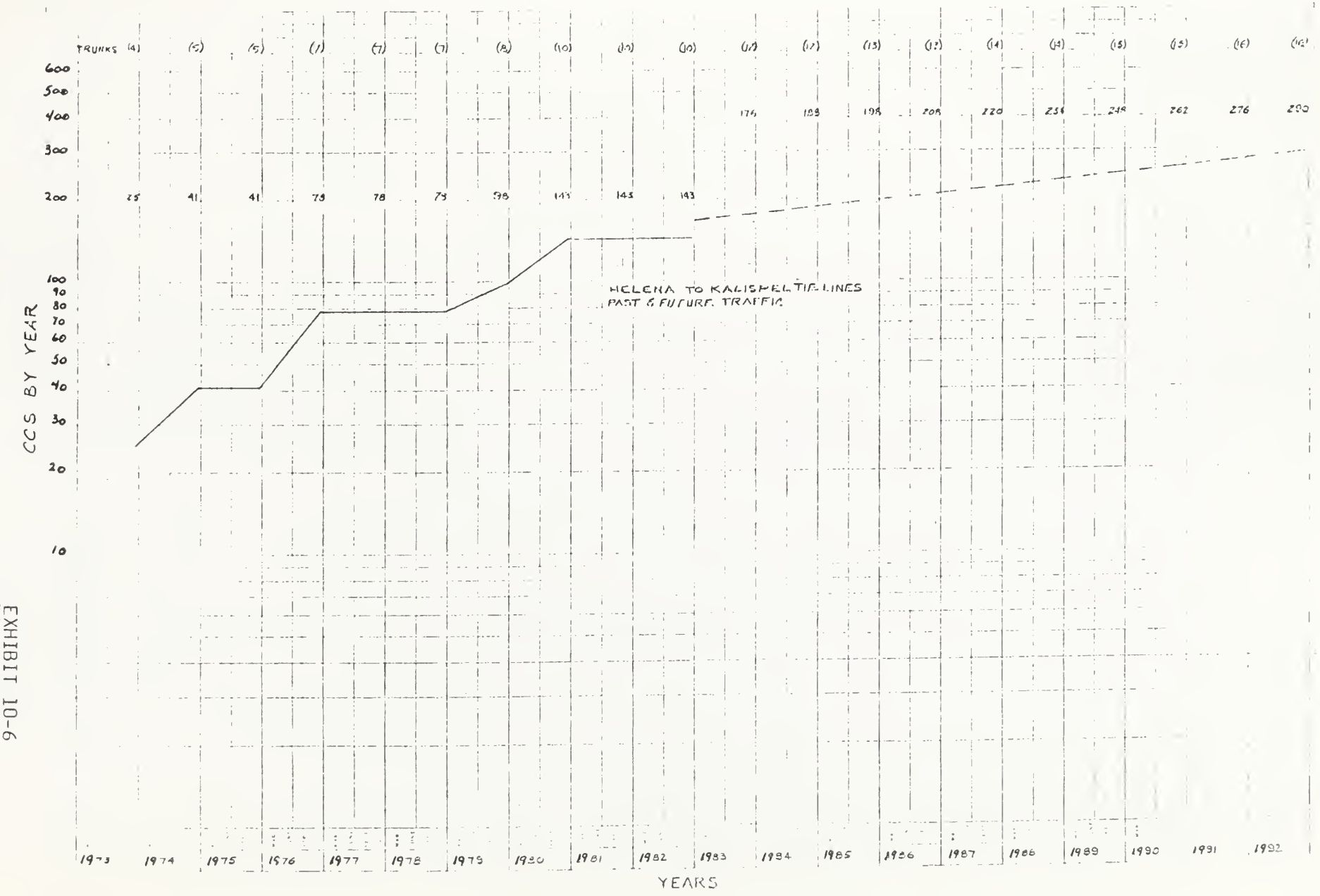

TRUNKS (4) (5) (5) (7) (7) (7) (8) (10) (10) (10) (17) (17) (13) (13) (14) (14) (15) (15) (16) (16)
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
25 41 41 79 78 79 98 143 143 143
176 188 198 208 220 236 248 262 276 290
CCS BY YEAR
HELENA TO KALISPELL TIE LINES
PAST & FUTURE TRAFFIC
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-6

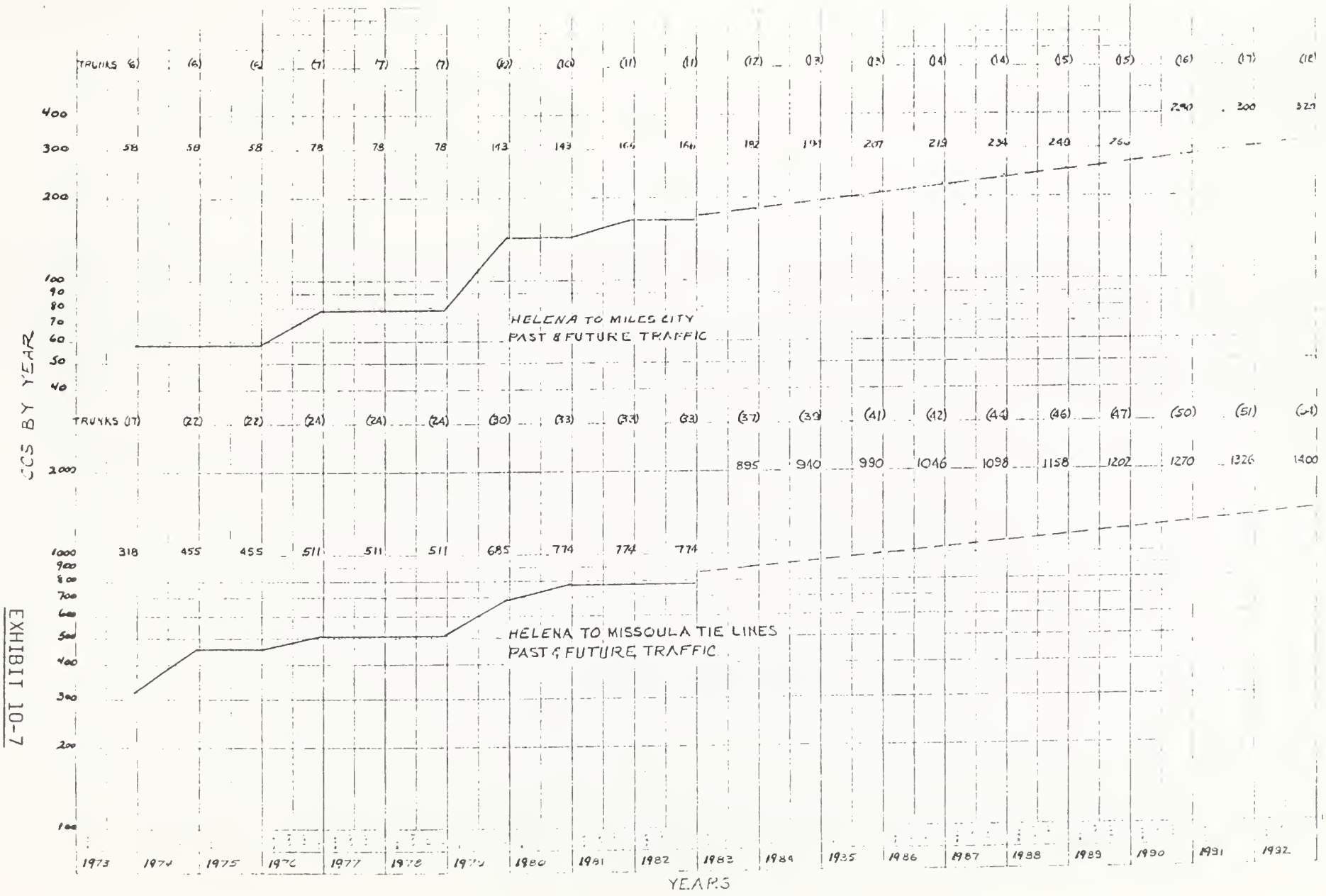

TRUNKS (6) (6) (6) (7) (7) (7) (9) (10) (11) (11) (12) (13) (13) (14) (14) (15) (15) (16) (17) (18)
400
300 58 58 58 78 78 78 143 143 166 166 192 193 207 219 234 240 260 280 300 320
200
100
90
80
70
60
50
40
TRUNKS (17) (22) (22) (24) (24) (24) (30) (33) (33) (33) (37) (39) (41) (42) (44) (46) (47) (50) (51) (54)
2000
895 940 990 1046 1098 1158 1202 1270 1326 1400
1000 318 455 455 511 511 511 685 774 774 774
900
800
700
600
500
400
300
200
100
HELENA TO MILES CITY
PAST & FUTURE TRAFFIC
HELENA TO MISSOULA TIE LINES
PAST & FUTURE TRAFFIC
CCS BY YEAR
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-7

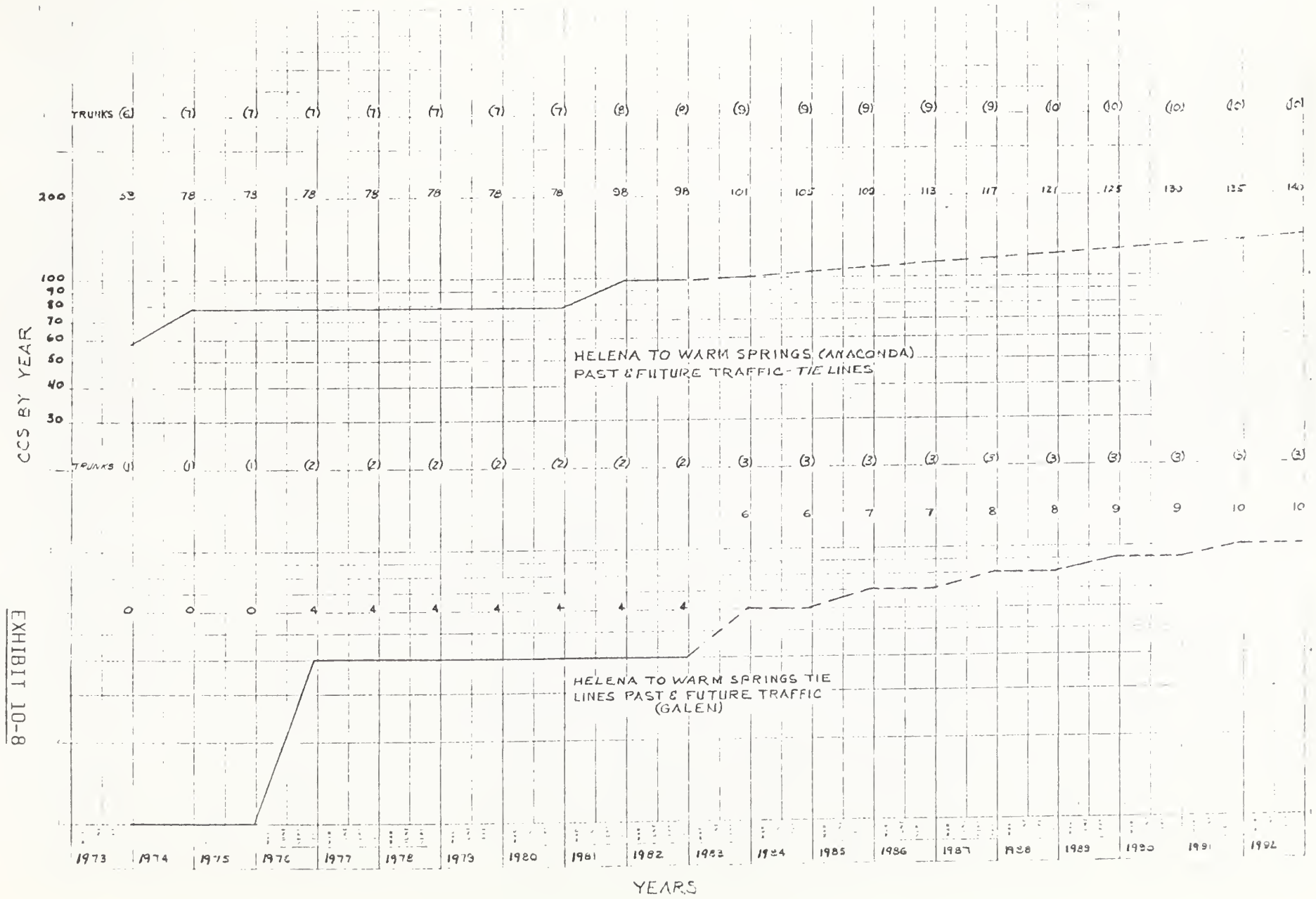

TRUNKS (6) (7) (7) (7) (7) (7) (7) (7) (8) (8) (9) (9) (9) (9) (9) (10) (10) (10) (10) (10)
200 52 78 78 78 78 78 78 78 98 98 101 105 109 113 117 121 125 130 135 140
100
90
80
70
60
50
40
30
CCS BY YEAR
TRUNKS (1) (1) (1) (2) (2) (2) (2) (2) (2) (2) (3) (3) (3) (3) (3) (3) (3) (3) (3)
6 6 7 7 8 8 9 9 10 10
0 0 0 4 4 4 4 4 4 4
HELENA TO WARM SPRINGS (ANACONDA)
PAST & FUTURE TRAFFIC - TIE LINES
HELENA TO WARM SPRINGS TIE
LINES PAST & FUTURE TRAFFIC
(GALEN)
1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
YEARS

EXHIBIT 10-8

Location	Telpak	VOICE										DATA				Total
		L/M Control Circuits														
		H/P	Hwy.	DRNC	F&G	L/M Total	METS	Lib	DES	Publ. Radio	Total Voice	CSD	Labor & Industry	Revenue	Total Data	
Anaconda	Yes			1		1	1				2		1	1	2	4
Big Timber	Yes						1				1			1	1	2
Billings	Yes	1	1	1	1	4	20	2	1	2	29	5	2	1	8	37
Boulder	Yes													1	1	1
Bozeman	Yes		1	1	1	3	1	1		1	6	3	2	1	5	11
Butte	Yes	1	1			2	1	1			4	3	1	1	5	9
Cut Bank	No						1				1		1	1	2	3
Deer Lodge	Yes											2		1	3	3
Dillon	Yes						1	1			2	1	1	1	3	5
Forsyth	Yes			1		1	1				2			1	1	3
Glasgow	No				1	1	1				2	1	1	1	3	5
Glendive	No	2	1			3	1				4	1	1	1	3	7
Great Falls	Yes	2	1		1	4	1		1		6	6	2	1	9	15
Hamilton	No											1	1	1	3	3
Havre	Yes		1			1	1	1			3	1	1	1	3	6
Helena	Yes	9	11	4		24	1				25	13	3	1	17	42
Kalispell	Yes	1	1	4	1	7	1				8	1	2	1	4	12
Lewistown	Yes	1	1	1		3	1				4	1	1	1	3	7
Livingston	No						1				1		1	1	2	3
Miles City	Yes		1		1	2	1		1		4	1	1	1	3	7
Missoula	Yes	1	1	13	1	16	1	1	1	1	20	4	3	1	8	28
Polson	Yes												1	1	2	2
Shelby	No						1				1	1	1	1	3	4
Sidney	No						1				1		1	1	2	3
Warm Spgs/Galen	Yes													1	1	1
Wolf Point	No	1				1	1				2	1	1	1	3	5

EXHIBIT 11

STATE OF MONTANA

CIRCUIT TERMINATION SUMMARY

1987 QUANTITIES

EXHIBIT 12-1

	EXIST. TELPAK POINT	SWITCHED	NON-SWITCHED (DEDICATED)		TOTAL
			VOICE	DATA	
Anaconda	Yes	9	2	2	13
Big Timber	Yes	6	1	1	8
Billings	Yes	37	29	8	74
Boulder	Yes	7	-	1	8
Bozeman	Yes	34	6	5	45
Butte	Yes	22	4	5	31
Cut Bank	No	5	1	2	8
Deer Lodge	Yes	9	-	3	12
Dillon	Yes	6	2	3	11
Forsyth	Yes	7	2	1	10
Glasgow	No	14	2	3	19
Glendive	No	15	4	3	22
Great Falls	Yes	25	6	9	40
Hamilton	No	12	-	3	15
Havre	Yes	12	3	3	18
Helena	Yes	307	25	17	349
Kalispell	Yes	14	8	4	26
Lewistown	Yes	17	4	3	24
Livingston	No	10	1	2	13
Miles City	Yes	14	4	3	21
Missoula	Yes	44	20	8	72
Polson	Yes	7	-	2	9
Shelby	No	11	1	3	15
Sidney	No	11	1	2	14
Warm Spgs/Galen	Yes	3	-	1	4
Wolf Point	No	7	2	3	12

STATE OF MONTANA

CIRCUIT TERMINATION SUMMARY

1992 QUANTITIES

EXHIBIT 12-2

	EXIST. TELPAK POINT	SWITCHED	NON-SWITCHED (DEDICATED)		TOTAL
			VOICE	DATA	
Anaconda	Yes	10	3	3	16
Big Timber	Yes	7	2	2	11
Billings	Yes	45	30	9	84
Boulder	Yes	8	1	2	11
Bozeman	Yes	40	7	6	53
Butte	Yes	27	5	6	38
Cut Bank	No	6	2	3	11
Deer Lodge	Yes	11	1	4	16
Dillon	Yes	7	3	4	14
Forsyth	Yes	8	3	2	13
Glasgow	No	17	3	4	24
Glendive	No	18	5	4	27
Great Falls	Yes	29	7	10	46
Hamilton	No	14	1	4	19
Havre	Yes	14	4	4	22
Helena	Yes	324	26	22	372
Kalispell	Yes	16	9	5	30
Lewistown	Yes	20	5	4	29
Livingston	No	12	2	3	17
Miles City	Yes	17	5	4	26
Missoula	Yes	53	21	9	83
Polson	Yes	8	1	3	12
Shelby	No	13	2	4	19
Sidney	No	13	2	3	18
Warm Spgs/Galen	Yes	3	1	2	6
Wolf Point	No	8	3	4	15

STATE OF MONTANA

CIRCUIT TERMINATION SUMMARY

1997 QUANTITIES

EXHIBIT 12-3

	EXIST. TELPAK POINT	SWITCHED	NON-SWITCHED (DEDICATED)		TOTAL
			VOICE	DATA	
Anaconda	Yes	11	4	4	19
Big Timber	Yes	8	3	3	14
Billings	Yes	52	35	11	98
Boulder	Yes	9	2	3	14
Bozeman	Yes	47	8	7	62
Butte	Yes	31	6	7	44
Cut Bank	No	7	3	4	14
Deer Lodge	Yes	12	2	5	19
Dillon	Yes	9	4	5	18
Forsyth	Yes	9	4	3	16
Glasgow	No	20	4	5	29
Glendive	No	21	6	5	32
Great Falls	Yes	33	8	12	53
Hamilton	No	16	2	5	23
Havre	Yes	16	5	5	26
Helena	Yes	378	30	26	434
Kalispell	Yes	19	10	6	35
Lewistown	Yes	23	6	5	34
Livingston	No	14	3	4	21
Miles City	Yes	20	6	5	31
Missoula	Yes	62	24	11	97
Polson	Yes	9	2	4	15
Shelby	No	15	3	5	23
Sidney	No	15	3	4	22
Warm Spgs/Galen	Yes	3	2	3	8
Wolf Point	No	9	4	5	18

SITE SELECTION ANALYSIS

City	Population Rank	County Seat	Telpak	State Agencies	State Inst. or Comm. College	Lens	Lens-High Speed	Hwy. Patrol Div.	Hwy. Dept. Div.	Agriculture	Commerce	Fish, W. & Parks	Institutions	Labor	DNRC	SRS	Total Points	On System
Billings	1	X	X	22	X	X	X	X	X	X		X	X	X	X	X	14	Yes
Great Falls	2	X	X	19		X	X	X	X	X	X	X	X	X	X	X	14	Yes
Butte	3	X	X	18	X	X	X	X	X	X		X	X	X		X	13	Yes
Missoula	4	X	X	19	X	X	X	X	X	X		X	X	X	X	X	14	Yes
Helena	5	X	X	C	X	X	X	HQ	HQ	X	X	X	X	X	X	X	15	Yes
Bozeman	6	X	X	17	X	X	X	X	X	X		X	X	X	X	X	14	Yes
Anaconda	7	X	X	7		X							X	X			6	Yes
Havre	8	X	X	10	X	X			X	X		X	X	X	X	X	12	Yes
Kalispell	9	X	X	16	X	X	X	X	X	X		X	X	X	X	X	14	Yes
Miles City	10	X	X	9	X	X			X	X		X	X	X	X	X	12	Yes
Lewistown	11	X	X	12	X	X	X	X	X	X		X	X	X	X	X	14	Yes
Livingston	12	X		7		X						X	X	X		X	7	Yes
Glendive	13	X		13	X	X			X	X		X	X	X	X	X	11	Yes
Sidney	14	X		10		X				X			X	X	X		7	Yes
Laurel	15	(SEE BILLINGS)																
Glasgow	16	X		11		X				X		X	X	X	X	X	9	Yes
Deer Lodge	17	X	X	8	X	X						X	X	X		X	9	Yes
Dillon	18	X	X	8	X	X				X		X	X	X			9	Yes
Whitefish	19	X		3		X						X					4	No
Cut Bank	20	X		4		X							X	X			5	Yes
Hardin	21	X		4		X	X					X	X				5	No
Shelby	22	X		9		X	X			X		X	X	X	X	X	9	Yes
Conrad	24	X		4		X				X			X				4	No
Wolf Point	25	X		6		X			X	X			X	X		X	7	Yes
Polson	26	X	X	6		X	X			X		X	X	X			8	Yes

NOTE: Population - Top 20 Towns = 1 Point

EXHIBIT 13
Page 1 of 3

City	Population Rank	County Seat	Telpak	State Agencies	State Inst. or Comm. College	Lens	Lens-High Speed	Hwy. Patrol Div.	Hwy. Dept. Div.	Agriculture	Commerce	Fish, W. & Parks	Institutions	Labor	DNRC	SRS	Total Points	On System
Libby	27	X		8		X						X	X	X			5	No
Hamilton	28	X		10		X	X			X		X	X	X	X		8	Yes
Forsyth	29	X	X	4		X						X	X				5	Yes
Plentywood	30	X		5		X						X	X				4	No
Malta	31	X		5		X						X	X				4	No
Baker	32	X		4		X				X		X					4	No
Roundup	34	X		6		X						X	X				4	No
Red Lodge	35	X		3		X						X	X				4	No
Choteau	36	X		4		X						X	X				4	No
Fort Benton	37	X	X	3		X						X					4	No
Big Timber	38	X	X	4		X	X					X	X				6	Yes
Chinook	39	X		6		X				X		X	X				5	No
Townsend	41	X		3		X						X					3	No
Thompson Falls	43	X		5		X						X	X	X			5	No
Boulder	44	X	X	4	X	X										X	5	Yes
Columbus	45	X		3		X						X	X				4	No
Scobey	46	X		2		X											2	No
Broadus	--	X		3		X						X					3	No
Chester	--	X		3		X							X				3	No
Stanford	--	X	X	3		X						X					4	No
Virginia City	--	X		1		X											2	No
W. Glacier	--			-		X											1	No
West Yellowstone	--			3		X						X					2	No

City	Population Rank	County Seat	Telpak	State Agencies	State Inst. or Comm. College	Lens	Lens-High Speed	Hwy. Patrol Div.	Hwy. Dept. Div.	Agriculture	Commerce	Fish, W. & Parks	Institutions	Labor	DNRC	SRS	Total Points	On System
Galen - Warm Springs	--		X	4	X												2	Yes
Ashland	--			5								X			X		2	No
Browning	50			5	X									X		X	3	No
Harlowtown	52	X		5	X							X	X				4	No

EXHIBIT 13
Page 3 of 3

STATE OF MONTANA

QUANTITY OF STATE OFFICES PER LOCATION

Community	Offices	Community	Offices	Community	Offices
Alberton	1	Conrad	5	Gallatin Gateway	1
Anaconda	9	Corvallis	2	Gardiner	1
Ashland	3	Crane	1	Garrison	1
Augusta	3	Creston	1	Glasgow	14
Baker	5	Creeks Camp	1	Glendive	15
Basin	1	Crow Agency	2	Great Falls	32
Beaverslide	1	Crystal Creek	4	Grass Range	1
Belgrade	3	Culbertson	2	Greenough	1
Belt	1	Custer	1	Hamilton	12
Big Fork	1	Cut Bank	5	Hardin	6
Big Sandy	1	Deep Creek	1	Harlem	2
Big Sky	1	Deer Lodge	10	Harlowton	7
Big Timber	6	Denton	1	Harrison	2
Billings	45*	Dillon	10*	Havre	12*
Bonner	1	Divide	1	Hillside	1
Boulder	4	Drummond	3	Hobson	3
Boyes	1	Duck Creek	1	Hot Springs	1
Bozeman	25*	Dupuyer	1	Huntley	1
Broadus	4	Dutton	1	Hysham	2
Browning	4	Ekalaka	1	Ingomar	1
Busby	1	Ennis	5	Jordan	2
Butte	23*	Eureka	2	Kalispell	22
Cascade	2	Fairfield	2	Lame Deer	1
Chester	4	Fiddleback	1	Laurel	1
Chinook	8	Flowing Wells	1	Lewistown	17
Choteau	5	Forsyth	7	Libby	13
Circle	4	Fort Benton	4	Lima	2
Colstrip	2	Frenchtown	2	Lincoln	3
Columbia Falls	4	Fromberg	1	Livingston	10
Columbus	4	Galen	1	Lodge Grass	1

* University Counted as One

Community	Offices	Community	Offices	Community	Offices
Lolo	1	Roundup	5	Thompson Falls	6
Malta	6	Roy	1	Three Forks	2
Miles City	15	Ryegate	2	Townsend	5
Missoula	34*	Saint Ignatius	1	Troy	2
Mobridge	1	Saint Mary	1	Twin Bridges	1
Moccasin	1	Saltese	1	Victor	1
Noxon	1	Scobey	3	Virginia City	1
Nyack	1	Seeley Lake	1	Walkerville	1
Opheim	1	Shelby	11	Warm Springs	3
Ovando	1	Sheridan	2	W. Yellowstone	3
Philipsburg	3	Sidney	11	Whitefish	3
Plains	2	Stanford	3	Whitehall	4
Plentywood	6	Stevensville	1	Wh Sulfur Spgs	4
Polson	7	Summit	1	Wibaux	3
Poplar	2	Sunburst	1	Wilsall	1
Rainy Lake	1	Sun River	1	Winnett	3
Ravalli	1	Superior	4	Wisdom	1
Red Lodge	4	Swan Lake	3	Wolf Creek	1
Ronan	4	Terry	2	Wolf Point	7

* University Counted as One

STATE OF MONTANA

TOWNS WITH TEN OR MORE OFFICES

Billings	(Telpak)
Bozeman	(Telpak)
Butte	(Telpak)
Deer Lodge	(Telpak)
Dillon	(Telpak)
Glasgow	
Glendive	
Great Falls	(Telpak)
Hamilton	
Havre	(Telpak)
Helena	(Telpak)
Kalispell	(Telpak)
Lewistown	(Telpak)
Libby	
Livingston	
Miles City	(Telpak)
Missoula	(Telpak)
Shelby	
Sidney	

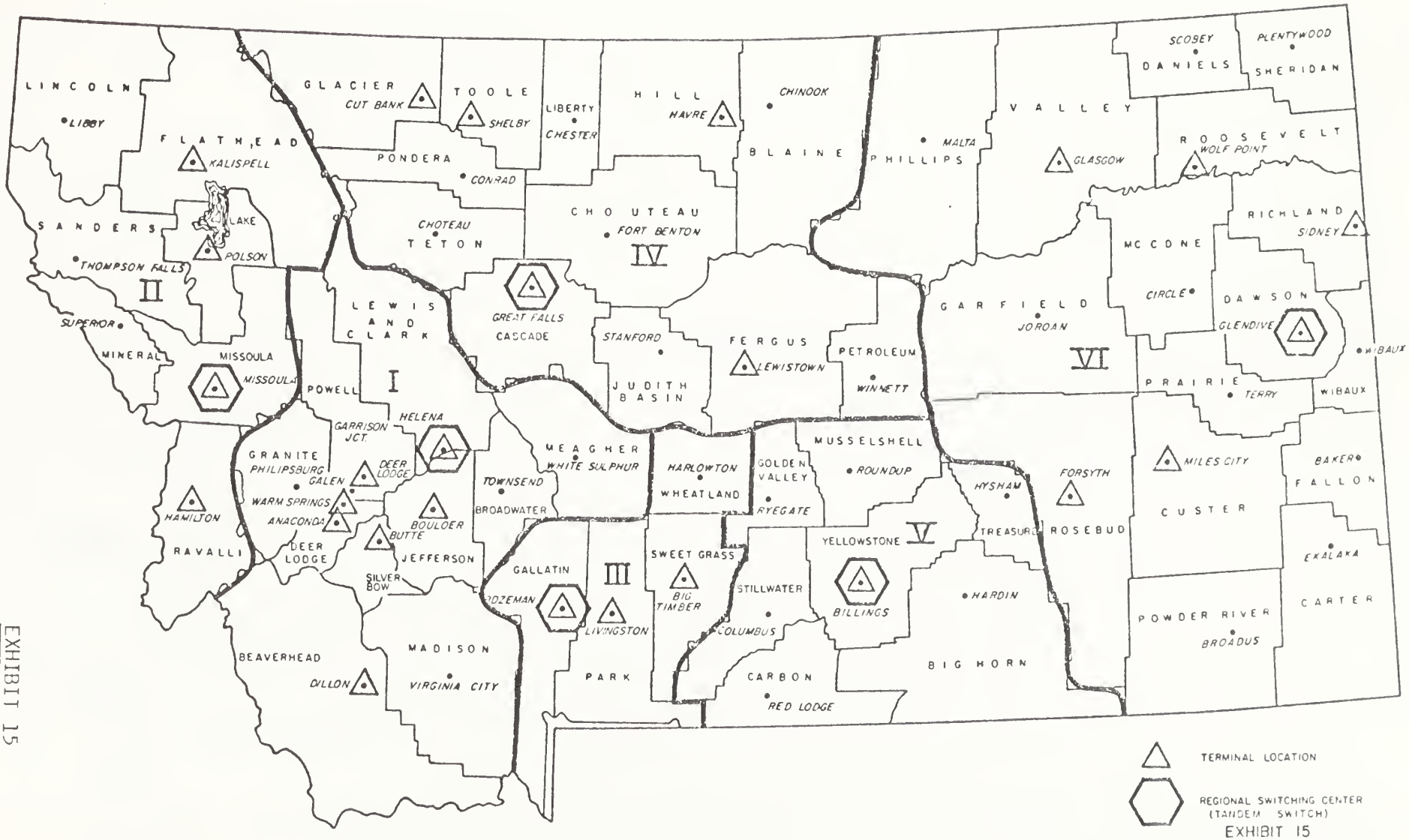


EXHIBIT 15

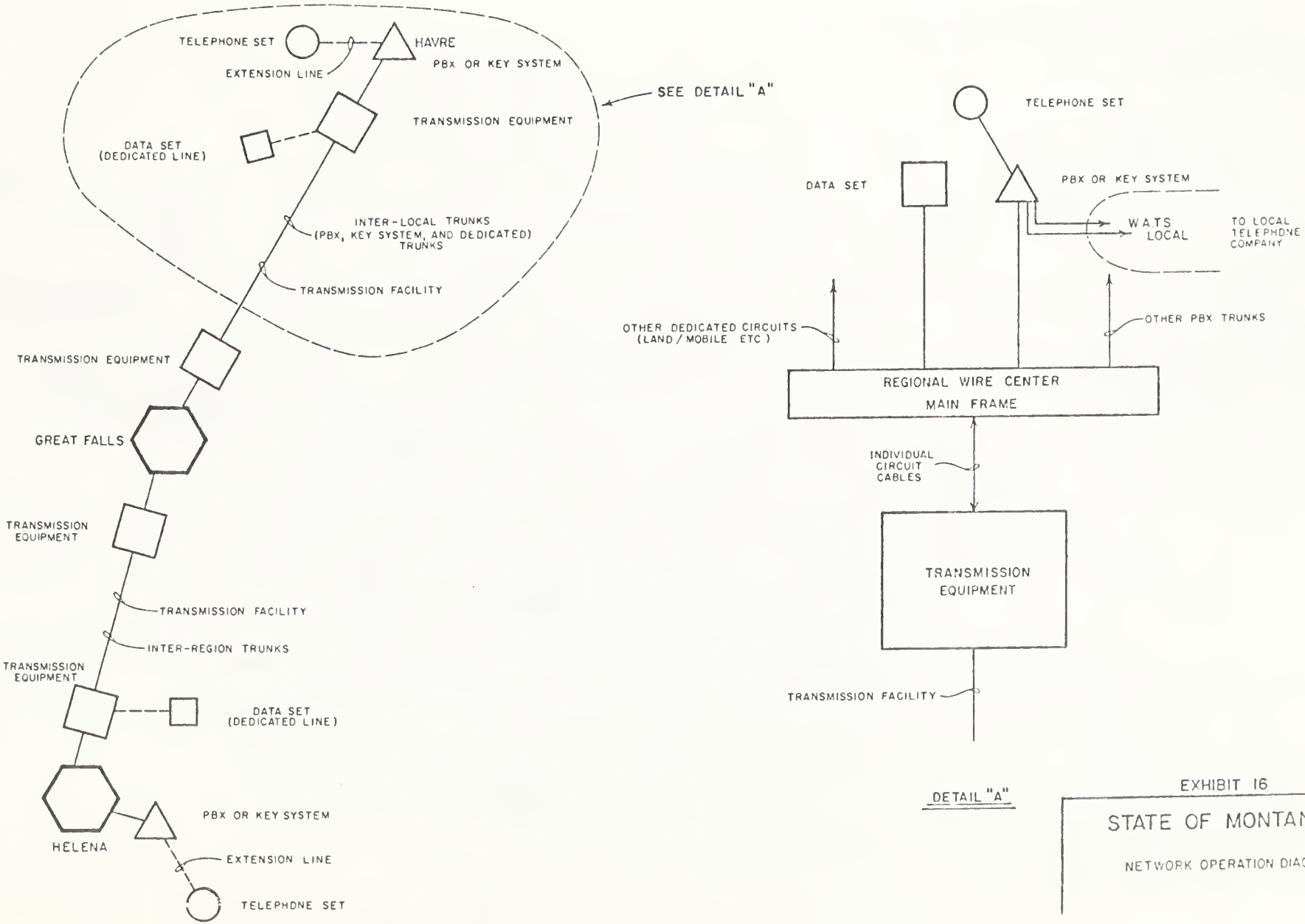
△ TERMINAL LOCATION

⬡ REGIONAL SWITCHING CENTER (TANDEM SWITCH)

EXHIBIT 15

STATE OF MONTANA

REGIONAL SWITCHING AREAS
– BOUNDARIES –



DETAIL "A"

EXHIBIT 16

STATE OF MONTANA

NETWORK OPERATION DIAGRAM

EXHIBIT 16

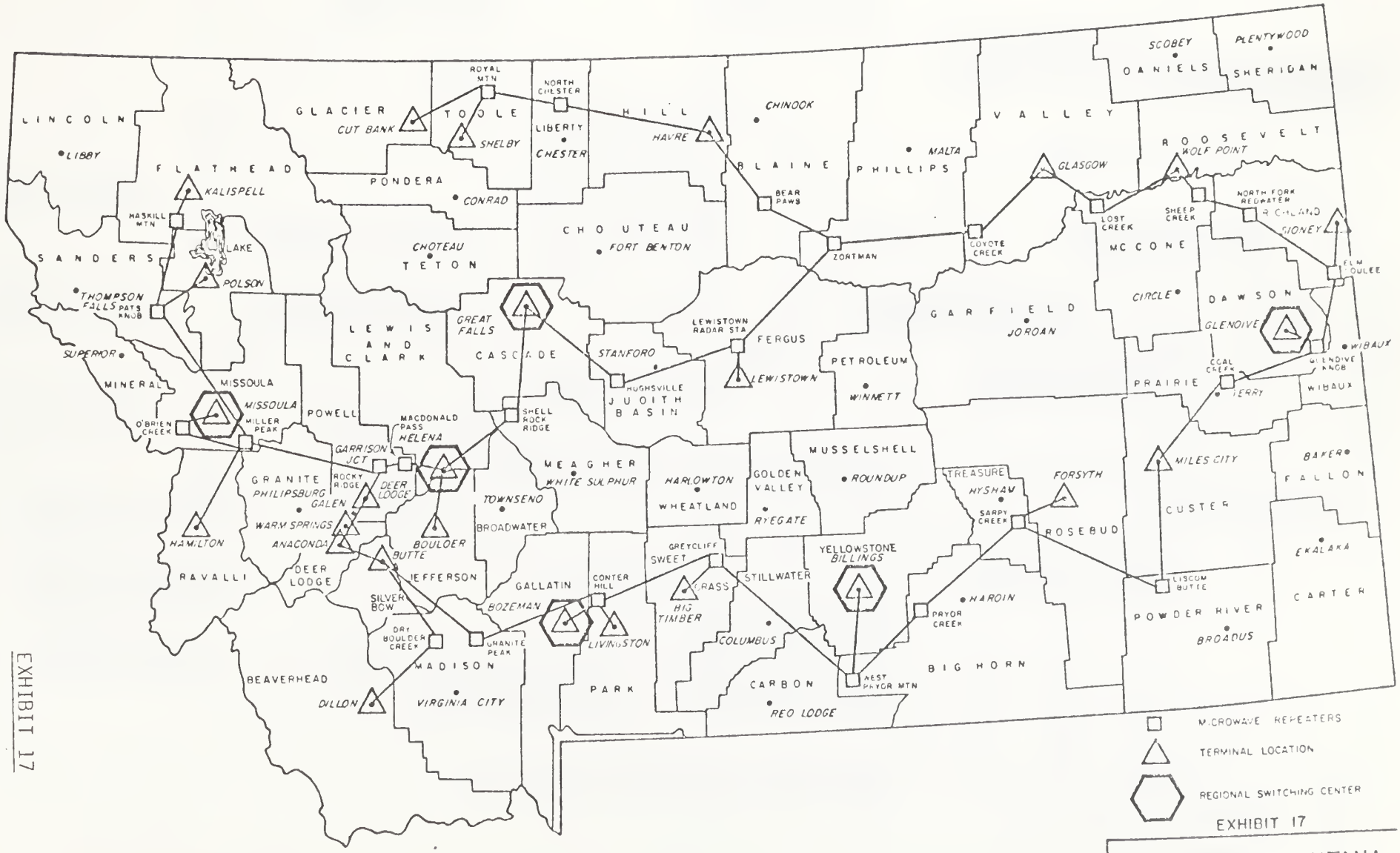


EXHIBIT 17

□ MICROWAVE REPEATERS

△ TERMINAL LOCATION

⬡ REGIONAL SWITCHING CENTER

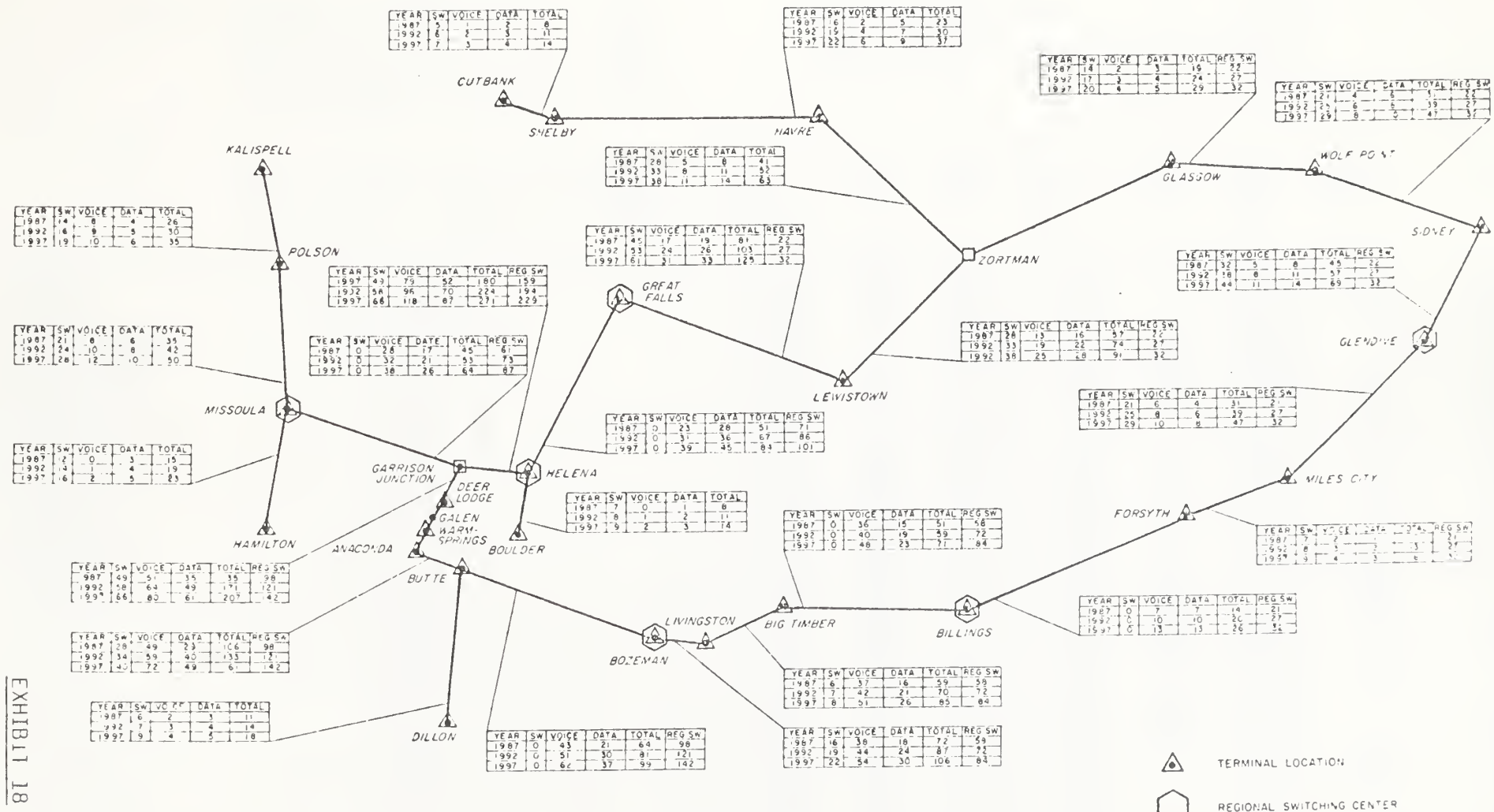
EXHIBIT 17

STATE OF MONTANA

PROPOSED

MICROWAVE TRANSMISSION SYSTEM

PLAN I



REG SW - SWITCHED TRUNKS FROM REGIONAL CENTER TO HELENA BASE
SW - SWITCHED TRUNKS FROM TERMINAL LOCATION OR LOCAL SWITCH

EXHIBIT 18

STATE OF MONTANA

TRUNKING DIAGRAM

MICROWAVE TRANSMISSION SYSTEM

PLAN I

EXHIBIT 18

STATE of MONT

MICROWAVE TRANSMISSION SYSTEM
Analog Microwave
1997 System Quantities
Plan 1

RF Terminal Cost/Unit	$ 29900	Channel Equip/Circuit	$ 1400
DC Power Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Point	$ 10000	Antenna System Cost/Antenna	$ 4500
(DC Pwr Supply Base Cost	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bdg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
Helena	1	229		4000	30	2	0	1	0	59800	9000	12000	20000	0	10000	320600	$ 431400
Boulder	1	28	29	4400	200	1	0	1	0	29900	4500	80000	17000	0	10000	39200	$ 180600
McDonald Pass	1		12	7100	30	0	0	4	1	95000	0	12000	0	0	40000	0	$ 147000
Rocky Ridge	1		19	5850	30	3	1	3	0	89700	13500	12000	23000	35000	30000	0	$ 203200
Miller Peak	1		60	7000	30	3	1	3	0	89700	13500	12000	23000	35000	30000	0	$ 203200
Hamilton	0	23	38	4100	30	1	0	1	0	29900	4500	12000	17000	0	10000	32200	$ 105600
O'Brien Creek	1		14	5000	30	0	0	1	1	95000	0	12000	0	0	10000	0	$ 117000
Missoula	1	151	6	3200	30	1	0	1	0	29900	4500	12000	17000	0	10000	211400	$ 284800
Pats Knob	1		61	6600	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Polson	1	15	42	3020	30	1	0	1	0	29900	4500	12000	17000	0	10000	21000	$ 94400
Haskill Mt.	1		50	6200	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Kalispell	1	35	16	3000	30	1	0	1	0	29900	4500	12000	17000	0	10000	49000	$ 122400
Deer Lodge	1	19	9	4600	50	2	1	2	0	59800	9000	20000	20000	35000	20000	26600	$ 190400
Anaconda	1	18	22	6000	30	2	1	2	0	59800	9000	12000	20000	35000	20000	25200	$ 181000
Butte	1	44	24	8250	30	3	1	4	0	89700	13500	12000	23000	35000	40000	61600	$ 274800
Dry Boulder Creek	1		30	8400	30	2	1	3	0	59800	9000	12000	20000	35000	30000	0	$ 165800
Dillon	1	18	36	5100	30	1	0	1	0	29900	4500	12000	17000	0	10000	25200	$ 98600
Granite Peak	1		40	9800	30	2	1	4	0	59800	9000	12000	20000	35000	40000	0	$ 175800
Conter Hill	1		44	7300	30	4	1	4	0	119600	18000	12000	26000	35000	40000	0	$ 250600
Bozeman	1	121	10	5000	30	1	0	1	0	29900	4500	12000	17000	0	10000	169400	$ 242800
Livingston	0	21	10	4500	40	1	0	1	0	29900	4500	16000	17000	0	10000	29400	$ 106800
Grey Cliff	1		56	5090	30	3	0	3	0	89700	13500	12000	23000	0	30000	0	$ 168200
Big Timber	0	14	14	3870	30	1	0	1	0	29900	4500	12000	17000	0	10000	19600	$ 93000
West Pryor Mt.	1		61	6690	30	3	1	2	0	89700	13500	12000	23000	35000	20000	0	$ 193200
Billings	1	98	32	3200	50	1	0	1	0	29900	4500	20000	17000	0	10000	137200	$ 218600
SUBTOTALS										1475700	193500	388000	451000	385000	500000	1167600	$ 4560800

Total Cost For Former Tel Pak Points $ 4255400

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bdg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
										---Technical Details---			---Extended Costs---				
SUBTOTALS										1475700	193500	388000	451000	385000	500000	1167600	4560800
Pryor Creek	1		35	4200	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Sarpy	1		61	4800	30	3	1	2	0	89700	13500	12000	23000	35000	20000	0	$ 193200
Forsyth	1	16	32	3200	30	1	0	1	0	29900	4500	12000	17000	0	10000	22400	$ 95800
Liscom Butte	1		45	4317	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Signal Butte	1		46	2900	230	3	1	2	0	89700	13500	92000	23000	35000	20000	0	$ 273200
Miles City	1	31	6	2500	40	1	0	1	0	29900	4500	16000	17000	0	10000	43400	$ 120800
Coal Creek	0		43	2900	180	2	1	2	0	59800	9000	72000	20000	35000	20000	0	$ 215800
Glendive Knob	0		30	2600	110	3	1	2	0	89700	13500	44000	23000	35000	20000	0	$ 225200
Glendive	0	180	8	2180	190	1	0	1	0	29900	4500	76000	17000	0	10000	252000	$ 389400
Elm Coulee	0		34	2500	250	3	1	3	0	89700	13500	100000	23000	35000	30000	0	$ 291200
Sidney	0	22	20	2000	30	1	0	1	0	29900	4500	12000	17000	0	10000	30800	$ 104200
N. F. Redwater	0		39	2700	150	2	1	2	0	59800	9000	60000	20000	35000	20000	0	$ 203800
Sheep Creek	0		35	2500	150	0	0	1	1	95000	0	60000	0	0	10000	0	$ 165000
Wolf Point	0	18	12	2000	50	2	0	1	0	59800	9000	20000	20000	0	10000	25200	$ 144000
Lost Creek	0		31	2700	100	0	0	1	1	95000	0	40000	0	0	10000	0	$ 145000
Coyote Creek	0		22	2400	30	3	1	2	0	89700	13500	12000	23000	35000	20000	0	$ 193200
Glasgow	0	29	3	2090	40	1	0	1	0	29900	4500	16000	17000	0	10000	40600	$ 118000
Willow Creek	0		28	3100	60	2	1	1	0	59800	9000	24000	20000	35000	10000	0	$ 157800
Zortman	1		62	5500	30	3	1	2	0	89700	13500	12000	23000	35000	20000	0	$ 193200
Bear Paws	1		45	5900	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Havre	1	26	24	2600	100	2	1	1	0	59800	9000	40000	20000	35000	10000	36400	$ 210200
Chester	0		42	3600	80	2	1	2	0	59800	9000	32000	20000	35000	20000	0	$ 175800
Mt. Royal	0		27	6900	30	3	1	2	0	89700	13500	12000	23000	35000	20000	0	$ 193200
Cut Bank	0	14	56	3850	100	1	0	1	0	29900	4500	40000	17000	0	10000	19600	$ 121000
Shelby	0	23	31	3290	50	1	0	1	0	29900	4500	20000	17000	0	10000	32200	$ 113600
Radar Site	1		57	6400	30	3	1	1	0	89700	13500	12000	23000	35000	10000	0	$ 183200
Lewistown	1	34	5	3700	40	1	0	1	0	29900	4500	16000	17000	0	10000	47600	$ 125000
Hughesville	1		54	8600	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Great Falls	1	222	44	3600	150	2	0	1	0	59800	9000	60000	20000	0	10000	310800	$ 469600
Shell Rock Ridge	1		41	7800	30	2	1	2	0	59800	9000	12000	20000	35000	20000	0	$ 155800
Helena	1	185	29	4000	0	1	0	1	0	29900	4500	0	17000	0	10000	259000	$ 320400
TOTALS										3370000	450000	1360000	1028000	1015000	970000	2287600	$ 10480600

Total Cost For Former Tel Pak Points $ 7219000

EXHIBIT 19-1

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave
1997 System Quantities
Plan 1

RF Terminal Cost/Unit	$ 68600	Channel Equip/Circuit	$ 325
DC Power Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Point	$ 10000	Antenna System Cost/Antenna	$ 4500
(DC Pwr Supply Base Cost	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bdg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
Helena	1	229		4000	30	2	0	1	0	137200	9000	12000	20000	0	10000	74425	$ 262625
Boulder	1	28	29	4400	200	1	0	1	0	68600	4500	80000	17000	0	10000	9100	$ 189200
McDonald Pass	1		12	7100	30	0	0	4	1	95000	0	12000	0	0	40000	0	$ 147000
Rocky Ridge	1		19	5850	30	3	1	3	0	205800	13500	12000	23000	35000	30000	0	$ 319300
Miller Peak	1		60	7000	30	3	1	3	0	205800	13500	12000	23000	35000	30000	0	$ 319300
Hamilton	0	23	38	4100	30	1	0	1	0	68600	4500	12000	17000	0	10000	7475	$ 119575
O'Brien Creek	1		14	5000	30	0	0	1	1	95000	0	12000	0	0	10000	0	$ 117000
Missoula	1	151	6	3200	30	1	0	1	0	68600	4500	12000	17000	0	10000	49075	$ 161175
Pats Knob	1		61	6600	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Polson	1	15	42	3020	30	1	0	1	0	68600	4500	12000	17000	0	10000	4875	$ 116975
Haskill Mt.	1		50	6200	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Kalispell	1	35	16	3000	30	1	0	1	0	68600	4500	12000	17000	0	10000	11375	$ 123475
Deer Lodge	1	19	9	4600	50	2	1	2	0	137200	9000	20000	20000	35000	20000	6175	$ 247375
Anaconda	1	18	22	6000	30	2	1	2	0	137200	9000	12000	20000	35000	20000	5850	$ 239050
Butte	1	44	24	8250	30	3	1	4	0	205800	13500	12000	23000	35000	40000	14300	$ 343600
Dry Boulder Creek	1		30	8400	30	2	1	3	0	137200	9000	12000	20000	35000	30000	0	$ 243200
Dillon	1	18	36	5100	30	1	0	1	0	68600	4500	12000	17000	0	10000	5850	$ 117950
Granite Peak	1		40	9800	30	2	1	4	0	137200	9000	12000	20000	35000	40000	0	$ 253200
Conter Hill	1		44	7300	30	4	1	4	0	274400	18000	12000	26000	35000	40000	0	$ 405400
Bozeman	1	121	10	5000	30	1	0	1	0	68600	4500	12000	17000	0	10000	39325	$ 151425
Livingston	0	21	10	4500	40	1	0	1	0	68600	4500	16000	17000	0	10000	6825	$ 122925
Grey Cliff	1		56	5090	30	3	0	3	0	205800	13500	12000	23000	0	30000	0	$ 284300
Big Timber	0	14	14	3870	30	1	0	1	0	68600	4500	12000	17000	0	10000	4550	$ 116650
West Pryor Mt.	1		61	6690	30	3	1	2	0	205800	13500	12000	23000	35000	20000	0	$ 309300
Billings	1	98	32	3200	50	1	0	1	0	68600	4500	20000	17000	0	10000	31850	$ 151950
SUBTOTALS										3139800	193500	388000	451000	385000	500000	271050	$ 5328350

Total Cost For Former Tel Pak Points $ 4969200

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bdg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
						Technical Details				Extended Costs							
SUBTOTALS										3139800	193500	388000	451000	385000	500000	271050	5328350
Pryor Creek	1		35	4200	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Sarpy	1		61	4800	30	3	1	2	0	205800	13500	12000	23000	35000	20000	0	$ 309300
Forsyth	1	16	32	3200	30	1	0	1	0	68600	4500	12000	17000	0	10000	5200	$ 117300
Liscom Butte	1		45	4317	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Signal Butte	1		46	2900	230	3	1	2	0	205800	13500	92000	23000	35000	20000	0	$ 389300
Miles City	1	31	6	2500	40	1	0	1	0	68600	4500	16000	17000	0	10000	10075	$ 126175
Coal Creek	0		43	2900	180	2	1	2	0	137200	9000	72000	20000	35000	20000	0	$ 293200
Glendive Knob	0		30	2600	110	3	1	2	0	205800	13500	44000	23000	35000	20000	0	$ 341300
Glendive	0	180	8	2180	190	1	0	1	0	68600	4500	76000	17000	0	10000	58500	$ 234600
Elm Coulee	0		34	2500	250	3	1	3	0	205800	13500	100000	23000	35000	30000	0	$ 407300
Sidney	0	22	20	2000	30	1	0	1	0	68600	4500	12000	17000	0	10000	7150	$ 119250
N. F. Redwater	0		39	2700	150	2	1	2	0	137200	9000	60000	20000	35000	20000	0	$ 281200
Sheep Creek	0		35	2500	150	0	0	1	1	95000	0	60000	0	0	10000	0	$ 165000
Wolf Point	0	18	12	2000	50	2	0	1	0	137200	9000	20000	20000	0	10000	5850	$ 202050
Lost Creek	0		31	2700	100	0	0	1	1	95000	0	40000	0	0	10000	0	$ 145000
Coyote Creek	0		22	2400	30	3	1	2	0	205800	13500	12000	23000	35000	20000	0	$ 309300
Glasgow	0	29	3	2090	40	1	0	1	0	68600	4500	16000	17000	0	10000	9425	$ 125525
Willow Creek	0		28	3100	60	2	1	1	0	137200	9000	24000	20000	35000	10000	0	$ 235200
Zortman	1		62	5500	30	3	1	2	0	205800	13500	12000	23000	35000	20000	0	$ 309300
Bear Paws	1		45	5900	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Havre	1	26	24	2600	100	2	1	1	0	137200	9000	40000	20000	35000	10000	8450	$ 259650
Chester	0		42	3600	80	2	1	2	0	137200	9000	32000	20000	35000	20000	0	$ 253200
Mt. Royal	0		27	6900	30	3	1	2	0	205800	13500	12000	23000	35000	20000	0	$ 309300
Cut Bank	0	14	56	3850	100	1	0	1	0	68600	4500	40000	17000	0	10000	4550	$ 144650
Shelby	0	23	31	3290	50	1	0	1	0	68600	4500	20000	17000	0	10000	7475	$ 127575
Radar Site	1		57	6400	30	3	1	1	0	205800	13500	12000	23000	35000	10000	0	$ 299300
Lewistown	1	34	5	3700	40	1	0	1	0	68600	4500	16000	17000	0	10000	11050	$ 127150
Hughesville	1		54	8600	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Great Falls	1	222	44	3600	150	2	0	1	0	137200	9000	60000	20000	0	10000	72150	$ 308350
Shell Rock Ridge	1		41	7800	30	2	1	2	0	137200	9000	12000	20000	35000	20000	0	$ 233200
Helena	1	185	29	4000	0	1	0	1	0	68600	4500	0	17000	0	10000	60125	$ 160225
TOTALS										7240000	450000	1360000	1028000	1015000	970000	531050	$ 12594050

Total Cost For Former Tel Pak Points $ 8741250

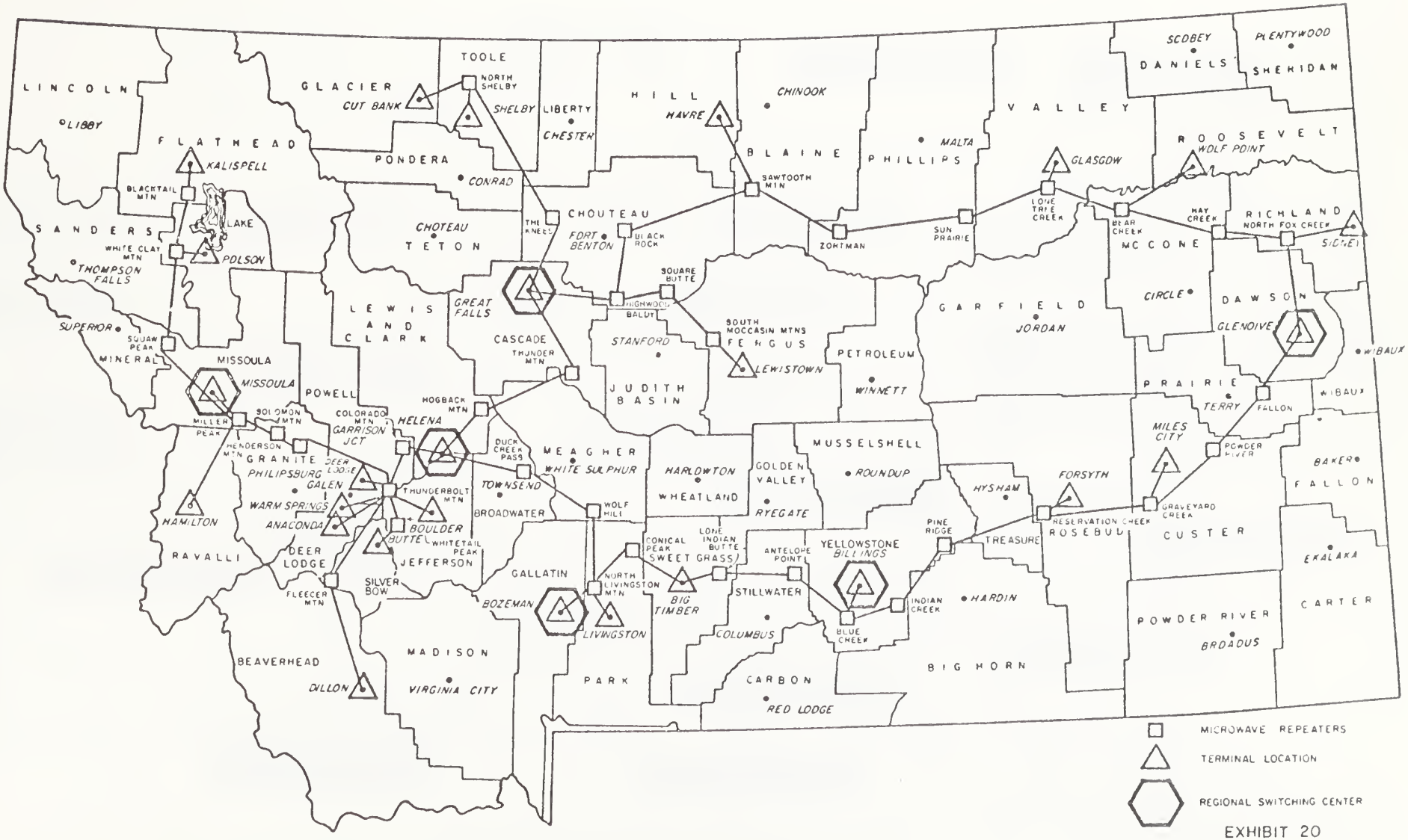
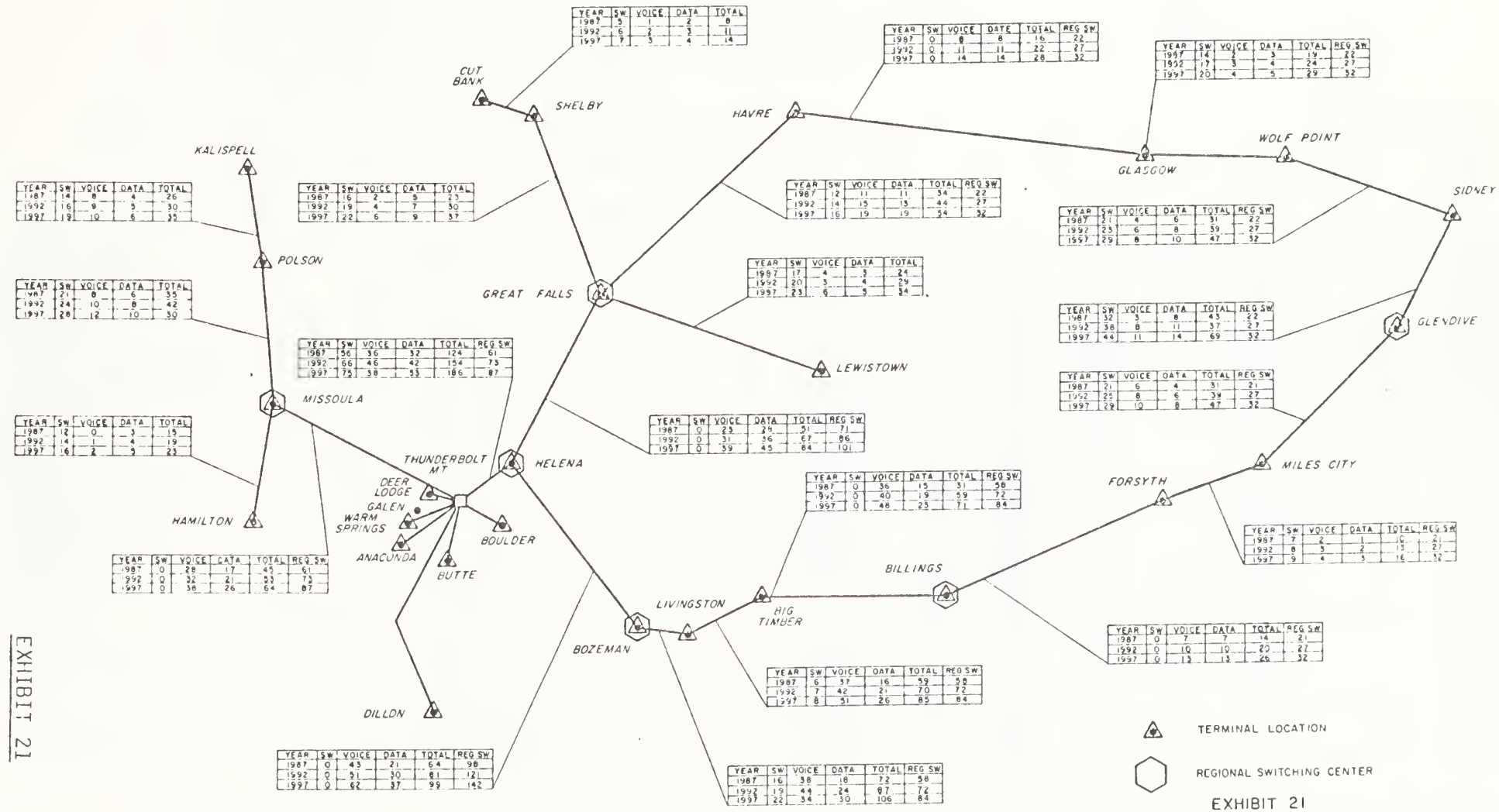


EXHIBIT 20

EXHIBIT 20

STATE OF MONTANA
PROPOSED
MICROWAVE TRANSMISSION SYSTEM
PLAN II



YEAR	SW	VOICE	DATA	TOTAL
1987	5	1	2	8
1992	6	2	3	11
1997	7	3	4	14

YEAR	SW	VOICE	DATE	TOTAL	REG SW
1987	0	8	8	16	22
1992	0	11	11	22	27
1997	0	14	14	28	32

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	14	2	3	19	22
1992	17	3	4	24	27
1997	20	4	5	29	32

YEAR	SW	VOICE	DATA	TOTAL
1987	14	8	4	26
1992	16	9	5	30
1997	19	10	6	35

YEAR	SW	VOICE	DATA	TOTAL
1967	16	2	5	23
1992	19	4	7	30
1997	22	6	9	37

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	12	11	11	34	22
1992	14	15	15	44	27
1997	16	19	19	54	32

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	21	4	6	31	22
1992	23	6	8	39	27
1997	29	8	10	47	32

YEAR	SW	VOICE	DATA	TOTAL
1987	17	4	3	24
1992	20	5	4	29
1997	23	6	5	34

YEAR	SW	VOICE	DATA	TOTAL
1987	21	8	6	35
1992	24	10	8	42
1997	28	12	10	50

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	32	5	8	45	22
1992	38	8	11	57	27
1997	44	11	14	69	32

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	56	36	32	124	61
1992	66	46	42	154	73
1997	75	58	53	186	87

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	21	6	4	31	21
1992	25	8	6	39	27
1997	29	10	8	47	32

YEAR	SW	VOICE	DATA	TOTAL
1987	12	0	3	15
1992	14	1	4	19
1997	16	2	5	23

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	0	23	24	31	71
1992	0	31	36	67	86
1997	0	39	45	84	101

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	0	36	15	31	58
1992	0	40	19	59	72
1997	0	48	23	71	84

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	7	2	1	10	21
1992	8	3	2	13	27
1997	9	4	3	16	32

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	0	28	17	45	61
1992	0	32	21	53	73
1997	0	38	26	64	87

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	0	7	7	14	21
1992	0	10	10	20	27
1997	0	13	13	26	32

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	6	37	16	59	58
1992	7	42	21	70	72
1997	8	51	26	85	84

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	0	43	21	64	98
1992	0	51	30	81	121
1997	0	62	37	99	142

YEAR	SW	VOICE	DATA	TOTAL	REG SW
1987	16	38	18	72	58
1992	19	44	24	87	72
1997	22	54	30	106	84

* REG SW - SWITCHED TRUNKS FROM REGIONAL CENTER TO HELENA BASE
SW - SWITCHED TRUNKS FROM TERMINAL LOCATION OR LOCAL SWITCH

EXHIBIT 21

STATE OF MONTANA

TRUNKING DIAGRAM
MICROWAVE TRANSMISSION SYSTEM
PLAN II

EXHIBIT 21

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Analog Microwave
1997 System Quantities
Plan 2-West Route

RF Terminal Cost/Unit	$ 29900	Channel Equip/Circuit	$ 1400
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-WEST	1	276		4090	50	1	1	1	0	29900	4500	20000	17000	35000	10000	386400	$ 502800
Colorado Mt.	1		15	7223	50	1	1	4	0	29900	4500	20000	17000	35000	40000	0	$ 146400
Thunder Bolt Mt.	1		17	8597	80	7	1	4	0	209300	31500	32000	35000	35000	40000	0	$ 382800
Boulder	1	14	18	4400	200	1	0	1	0	29900	4500	80000	17000	0	10000	19600	$ 161000
Deer Lodge	1	19	14	4521	40	1	0	1	0	29900	4500	16000	17000	0	10000	26600	$ 104000
Warm Springs/Galen	1	8	19	4420	40	1	0	1	0	29900	4500	16000	17000	0	10000	11200	$ 88600
Anaconda	1	19	28	5265	30	1	0	1	0	29900	4500	12000	17000	0	10000	26600	$ 100000
White Tail Peak	1		19	8475	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Butte	1	44	10	5549	40	1	0	1	0	29900	4500	16000	17000	0	10000	61600	$ 139000
Mount Fleecer	1		39	9436	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Dillon	1	18	44	5096	40	1	0	1	0	29900	4500	16000	17000	0	10000	25200	$ 102600
Henderson Mt.	1		43	7087	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Solomon Mt.	1		22	6916	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Miller Peak	1		13	7018	50	2	1	4	0	59800	9000	20000	20000	35000	40000	0	$ 183800
Hamilton	0	23	38	4100	30	1	0	1	0	29900	4500	12000	17000	0	10000	32200	$ 105600
Missoula	1	224	10	3227	40	1	0	1	0	29900	4500	16000	17000	0	10000	313600	$ 391000
Squaw Peak	1		36	7996	30	0	0	3	1	95000	0	12000	0	0	30000	0	$ 137000
White Clay Mt.	1		35	5680	30	2	1	4	0	59800	9000	12000	20000	35000	40000	0	$ 175800
Polson	1	15	31	3022	30	1	0	1	0	29900	4500	12000	17000	0	10000	21000	$ 94400
Blacktail Mt.	1		26	6757	30	0	1	2	1	95000	0	12000	0	35000	20000	0	$ 162000
Kalispell	1	35	16	3000	30	1	0	1	0	29900	4500	12000	17000	0	10000	49000	$ 122400
TOTALS										1257700	103500	420000	279000	210000	440000	973000	3683200

Total Route Cost For Former Tel Pak Points $ 3577600

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Analog Microwave
1997 System Quantities
Plan 2-East Route

RF Terminal Cost/Unit	$ 29900	Channel Equip/Circuit	$ 1400
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
				Technical Details						Extended Costs							
HELENA-EAST	1	241		4090	50	1	0	1	0	29900	4500	20000	17000	0	10000	337400	$ 418800
Duck Creek Pass	1		38	7515	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Wolf Hill	1		36	6662	50	0	0	2	1	95000	0	20000	0	0	20000	0	$ 135000
No. Livingston Mt.	1		31	7964	60	4	1	3	0	119600	18000	24000	26000	35000	30000	0	$ 252600
Bozeman	1	108	14	4810	50	1	0	1	0	29900	4500	20000	17000	0	10000	151200	$ 232600
Livingston	0	21	12	4503	40	1	0	1	0	29900	4500	16000	17000	0	10000	29400	$ 106800
Conical Peak	1		28	10731	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Big Timber	1	14	28	3870	30	2	0	1	0	59800	9000	12000	20000	0	10000	19600	$ 130400
Lone Indian Butte	1		19	5197	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Antelope Point	1		28	4560	40	2	1	2	0	59800	9000	16000	20000	35000	20000	0	$ 159800
Blue Creek Rptr	1		29	4000	40	3	1	2	0	89700	13500	16000	23000	35000	20000	0	$ 197200
Billings	1	98	10	3124	50	1	0	1	0	29900	4500	20000	17000	0	10000	137200	$ 218600
Indian Creek Rptr	1		20	4204	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Pine Ridge	1		32	3777	50	2	1	1	0	59800	9000	20000	20000	35000	10000	0	$ 153800
Reservation Creek	1		40	3500	100	3	1	1	0	89700	13500	40000	23000	35000	10000	0	$ 211200
Forsyth	1	16	12	3200	30	1	0	1	0	29900	4500	12000	17000	0	10000	22400	$ 95800
Graveyard Creek	1		39	3000	150	3	1	1	0	89700	13500	60000	23000	35000	10000	0	$ 231200
Miles City	1	31	18	2500	40	1	0	1	0	29900	4500	16000	17000	0	10000	43400	$ 120800
Powder River Rptr	0		38	3343	180	2	1	1	0	59800	9000	72000	20000	35000	10000	0	$ 205800
Fallon Creek Rptr	0		26	2665	120	2	1	1	0	59800	9000	48000	20000	35000	10000	0	$ 181800
Glendive	0	90	29	2180	190	1	0	1	0	29900	4500	76000	17000	0	10000	126000	$ 263400
TOTALS										1372000	135000	584000	314000	280000	300000	866600	$ 3851600

Total Route Cost For Former Tel Pak Points $ 3093800

STATE of MONTA

MICROWAVE TRANSMISSION SYSTEM
Analog Microwave
1997 System Quantities
Plan 2-North Route

RF Terminal Cost/Unit	$ 29900	Channel Equip/Circuit	$ 1400
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-NORTH	1	101		4090	50	1	0	1	0	29900	4500	20000	17000	0	10000	141400	$ 222800
Hog Back Mt.	1		22	7813	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Thunder Mt.	1		41	8050	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Great Falls	1	101	38	3336	250	3	0	1	0	89700	13500	100000	23000	0	10000	141400	$ 377600
The Knees	0		36	3500	50	0	0	1	1	95000	0	20000	0	0	10000	0	$ 125000
Shelby North Rptr	0		42	3500	50	3	1	2	0	89700	13500	20000	23000	35000	20000	0	$ 201200
Shelby	0	23	1	3286	30	1	0	1	0	29900	4500	12000	17000	0	10000	32200	$ 105600
Cut Bank	0	14	25	3340	50	1	0	1	0	29900	4500	20000	17000	0	10000	19600	$ 101000
Highwood Baldy	1		32	7625	50	3	0	0	0	89700	13500	20000	23000	0	0	0	$ 146200
Square Butte	1		19	5684	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
S Mocassin Mt Rptr	1		41	4080	40	0	0	2	1	95000	0	16000	0	0	20000	0	$ 131000
Lewistown	1	34	8	3693	40	1	0	1	0	29900	4500	16000	17000	0	10000	47600	$ 125000
Black Rock	1		42	3002	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
Sawtooth Mt.	1		39	5246	50	3	1	3	0	89700	13500	20000	23000	35000	30000	0	$ 211200
Havre	1	26	37	2529	40	1	0	1	0	29900	4500	16000	17000	0	10000	36400	$ 113800
Zortman	0		41	5500	40	2	1	3	0	59800	9000	16000	20000	35000	30000	0	$ 169800
Sun Prairie	0		43	2500	200	2	1	2	0	59800	9000	80000	20000	35000	20000	0	$ 223800
Lone Tree Creek	0		34	2500	180	3	1	2	0	89700	13500	72000	23000	35000	20000	0	$ 253200
Glasgow	0	29	23	2090	40	1	0	1	0	29900	4500	16000	17000	0	10000	40600	$ 118000
Bear Creek	0		39	2500	200	3	1	2	0	89700	13500	80000	23000	35000	20000	0	$ 261200
Wolf Point	0	18	27	2678	40	1	0	1	0	29900	4500	16000	17000	0	10000	25200	$ 102600
Hay Creek	0		40	2500	200	0	0	0	1	95000	0	80000	0	0	0	0	$ 175000
North Fox Creek	0		40	2500	200	3	1	2	0	89700	13500	80000	23000	35000	20000	0	$ 261200
Sidney	0	22	16	1829	50	1	0	1	0	29900	4500	20000	17000	0	10000	30800	$ 112200
Glendive	0	101	40	2180	190	1	0	1	0	29900	4500	76000	17000	0	10000	141400	$ 278800
TOTALS										1651700	148500	800000	337000	245000	360000	515200	$ 4057400

Total Route Cost For Former Tel Pak Points $ 1847600

PLAN TOTAL: $11,592,200

EXHIBIT 22-1

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave
1997 System Quantities
Plan 2-North Route

MEDIUM DENSITY

RF Terminal Cost/Unit	$ 68600	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
	Technical Details									Extended Costs							
HELENA-NORTH	1	101		4090	50	1	0	1	0	68600	4500	20000	17000	0	10000	32825	$ 152925
Hog Back Mt.	1		22	7813	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Thunder Mt.	1		41	8050	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Great Falls	1	101	38	3336	250	3	0	1	0	205800	13500	100000	23000	0	10000	32825	$ 385125
The Knees	0		36	3500	50	0	0	1	1	95000	0	20000	0	0	10000	0	$ 125000
Shelby North Rptr	0		42	3500	50	3	1	2	0	205800	13500	20000	23000	35000	20000	0	$ 317300
Shelby	0	23	1	3286	30	1	0	1	0	68600	4500	12000	17000	0	10000	7475	$ 119575
Cut Bank	0	14	25	3340	50	1	0	1	0	68600	4500	20000	17000	0	10000	4550	$ 124650
Highwood Baldy	1		32	7625	50	3	0	0	0	205800	13500	20000	23000	0	0	0	$ 262300
Square Butte	1		19	5684	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
S Mocassin Mt Rptr	1		41	4080	40	0	0	2	1	95000	0	16000	0	0	20000	0	$ 131000
Lewistown	1	34	8	3693	40	1	0	1	0	68600	4500	16000	17000	0	10000	11050	$ 127150
Black Rock	1		42	3002	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
Sawtooth Mt.	1		39	5246	50	3	1	3	0	205800	13500	20000	23000	35000	30000	0	$ 327300
Havre	1	26	37	2529	40	1	0	1	0	68600	4500	16000	17000	0	10000	8450	$ 124550
Zortman	0		41	5500	40	2	1	3	0	137200	9000	16000	20000	35000	30000	0	$ 247200
Sun Prairie	0		43	2500	200	2	1	2	0	137200	9000	80000	20000	35000	20000	0	$ 301200
Lone Tree Creek	0		34	2500	180	3	1	2	0	205800	13500	72000	23000	35000	20000	0	$ 369300
Glasgow	0	29	23	2090	40	1	0	1	0	68600	4500	16000	17000	0	10000	9425	$ 125525
Bear Creek	0		39	2500	200	3	1	2	0	205800	13500	80000	23000	35000	20000	0	$ 377300
Wolf Point	0	18	27	2678	40	1	0	1	0	68600	4500	16000	17000	0	10000	5850	$ 121950
Hay Creek	0		40	2500	200	0	0	0	1	95000	0	80000	0	0	0	0	$ 175000
North Fox Creek	0		40	2500	200	3	1	2	0	205800	13500	80000	23000	35000	20000	0	$ 377300
Sidney	0	22	16	1829	50	1	0	1	0	68600	4500	20000	17000	0	10000	7150	$ 127250
Glendive	0	101	40	2180	190	1	0	1	0	68600	4500	76000	17000	0	10000	32825	$ 208925
TOTALS										2928800	148500	800000	337000	245000	360000	119600	$ 4938900

Total Route Cost For Former Tel Pak Points $ 2030350

STATE of MONTA

MEDIUM DENSITY

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave
1997 System Quantities
Plan 2-West Route

RF Terminal Cost/Unit	$ 68600	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
	Technical Details									Extended Costs							
HELENA-WEST	1	276		4090	50	1	1	1	0	68600	4500	20000	17000	35000	10000	89700	$ 244800
Colorado Mt.	1		15	7223	50	1	1	4	0	68600	4500	20000	17000	35000	40000	0	$ 185100
Thunder Bolt Mt.	1		17	8597	80	7	1	4	0	480200	31500	32000	35000	35000	40000	0	$ 653700
Boulder	1	14	18	4400	200	1	0	1	0	68600	4500	80000	17000	0	10000	4550	$ 184650
Deer Lodge	1	19	14	4521	40	1	0	1	0	68600	4500	16000	17000	0	10000	6175	$ 122275
Warm Springs/Galen	1	8	19	4420	40	1	0	1	0	68600	4500	16000	17000	0	10000	2600	$ 118700
Anaconda	1	19	28	5265	30	1	0	1	0	68600	4500	12000	17000	0	10000	6175	$ 118275
White Tail Peak	1		19	8475	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Butte	1	44	10	5549	40	1	0	1	0	68600	4500	16000	17000	0	10000	14300	$ 130400
Mount Fleecer	1		39	9436	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Dillon	1	18	44	5096	40	1	0	1	0	68600	4500	16000	17000	0	10000	5850	$ 121950
Henderson Mt.	1		43	7087	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Solomon Mt.	1		22	6916	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Miller Peak	1		13	7018	50	2	1	4	0	137200	9000	20000	20000	35000	40000	0	$ 261200
Hamilton	0	23	38	4100	30	1	0	1	0	68600	4500	12000	17000	0	10000	7475	$ 119575
Missoula	1	224	10	3227	40	1	0	1	0	68600	4500	16000	17000	0	10000	72800	$ 188900
Squaw Peak	1		36	7996	30	0	0	3	1	95000	0	12000	0	0	30000	0	$ 137000
White Clay Mt.	1		35	5680	30	2	1	4	0	137200	9000	12000	20000	35000	40000	0	$ 253200
Polson	1	15	31	3022	30	1	0	1	0	68600	4500	12000	17000	0	10000	4875	$ 116975
Blacktail Mt.	1		26	6757	30	0	1	2	1	95000	0	12000	0	35000	20000	0	$ 162000
Kalispell	1	35	16	3000	30	1	0	1	0	68600	4500	12000	17000	0	10000	11375	$ 123475
TOTALS										2147800	103500	420000	279000	210000	440000	225875	3826175

Total Route Cost For Former Tel Pak Points $ 3706600

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave
1997 System Quantities
Plan 2-East Route

MEDIUM DENSITY

RF Terminal Cost/Unit	$ 68600	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-EAST	1	241		4090	50	1	0	1	0	68600	4500	20000	17000	0	10000	78325	$ 198425
Duck Creek Pass	1		38	7515	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Wolf Hill	1		36	6662	50	0	0	2	1	95000	0	20000	0	0	20000	0	$ 135000
No. Livingston Mt.	1		31	7964	60	4	1	3	0	274400	18000	24000	26000	35000	30000	0	$ 407400
Bozeman	1	108	14	4810	50	1	0	1	0	68600	4500	20000	17000	0	10000	35100	$ 155200
Livingston	0	21	12	4503	40	1	0	1	0	68600	4500	16000	17000	0	10000	6825	$ 122925
Conical Peak	1		28	10731	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Big Timber	1	14	28	3870	30	2	0	1	0	137200	9000	12000	20000	0	10000	4550	$ 192750
Lone Indian Butte	1		19	5197	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Antelope Point	1		28	4560	40	2	1	2	0	137200	9000	16000	20000	35000	20000	0	$ 237200
Blue Creek Rptr	1		29	4000	40	3	1	2	0	205800	13500	16000	23000	35000	20000	0	$ 313300
Billings	1	98	10	3124	50	1	0	1	0	68600	4500	20000	17000	0	10000	31850	$ 151950
Indian Creek Rptr	1		20	4204	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Pine Ridge	1		32	3777	50	2	1	1	0	137200	9000	20000	20000	35000	10000	0	$ 231200
Reservation Creek	1		40	3500	100	3	1	1	0	205800	13500	40000	23000	35000	10000	0	$ 327300
Forsyth	1	16	12	3200	30	1	0	1	0	68600	4500	12000	17000	0	10000	5200	$ 117300
Graveyard Creek	1		39	3000	150	3	1	1	0	205800	13500	60000	23000	35000	10000	0	$ 347300
Miles City	1	31	18	2500	40	1	0	1	0	68600	4500	16000	17000	0	10000	10075	$ 126175
Powder River Rptr	0		38	3343	180	2	1	1	0	137200	9000	72000	20000	35000	10000	0	$ 283200
Fallon Creek Rptr	0		26	2665	120	2	1	1	0	137200	9000	48000	20000	35000	10000	0	$ 259200
Glendive	0	90	29	2180	190	1	0	1	0	68600	4500	76000	17000	0	10000	29250	$ 205350
TOTALS										2533000	135000	584000	314000	280000	300000	201175	$ 4347175

Total Route Cost For Former Tel Pak Points $ 3476500

PLAN TOTAL: $13,112,250

STATE of MONTANA

LOW DENSITY

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave-Low Density
1997 System Quantities
Plan 2-North Route

RF Terminal Cost/Unit	$ 56900	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	Technical Details: # Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	Extended Costs: RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-NORTH	1	101		4090	50	1	0	1	0	56900	4500	20000	17000	0	10000	32825	$ 141225
Hog Back Mt.	1		22	7813	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Thunder Mt.	1		41	8050	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Great Falls	1	101	38	3336	250	3	0	1	0	170700	13500	100000	23000	0	10000	32825	$ 350025
The Knees	0		36	3500	50	0	0	1	1	95000	0	20000	0	0	10000	0	$ 125000
Shelby North Rptr	0		42	3500	50	3	1	2	0	170700	13500	20000	23000	35000	20000	0	$ 282200
Shelby	0	23	1	3286	30	1	0	1	0	56900	4500	12000	17000	0	10000	7475	$ 107875
Cut Bank	0	14	25	3340	50	1	0	1	0	56900	4500	20000	17000	0	10000	4550	$ 112950
Highwood Baldy	1		32	7625	50	3	0	0	0	170700	13500	20000	23000	0	0	0	$ 227200
Square Butte	1		19	5684	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
S Mocassin Mt Rptr	1		41	4080	40	0	0	2	1	95000	0	16000	0	0	20000	0	$ 131000
Lewistown	1	34	8	3693	40	1	0	1	0	56900	4500	16000	17000	0	10000	11050	$ 115450
Black Rock	1		42	3002	30	0	0	2	1	95000	0	12000	0	0	20000	0	$ 127000
Sawtooth Mt.	1		39	5246	50	3	1	3	0	170700	13500	20000	23000	35000	30000	0	$ 292200
Havre	1	26	37	2529	40	1	0	1	0	56900	4500	16000	17000	0	10000	8450	$ 112850
Zortman	0		41	5500	40	2	1	3	0	113800	9000	16000	20000	35000	30000	0	$ 223800
Sun Prairie	0		43	2500	200	2	1	2	0	113800	9000	80000	20000	35000	20000	0	$ 277800
Lone Tree Creek	0		34	2500	180	3	1	2	0	170700	13500	72000	23000	35000	20000	0	$ 334200
Glasgow	0	29	23	2090	40	1	0	1	0	56900	4500	16000	17000	0	10000	9425	$ 113825
Bear Creek	0		39	2500	200	3	1	2	0	170700	13500	80000	23000	35000	20000	0	$ 342200
Wolf Point	0	18	27	2678	40	1	0	1	0	56900	4500	16000	17000	0	10000	5850	$ 110250
Hay Creek	0		40	2500	200	0	0	0	1	95000	0	80000	0	0	0	0	$ 175000
North Fox Creek	0		40	2500	200	3	1	2	0	170700	13500	80000	23000	35000	20000	0	$ 342200
Sidney	0	22	16	1829	50	1	0	1	0	56900	4500	20000	17000	0	10000	7150	$ 115550
Glendive	0	101	40	2180	190	1	0	1	0	56900	4500	76000	17000	0	10000	32825	$ 197225
TOTALS										2542700	148500	800000	337000	245000	360000	119600	$ 4552800

Total Route Cost For Former Tel Pak Points $ 1889950

STATE of MONTANA

LOW DENSITY

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave-Low Density
1997 System Quantities
Plan 2-West Route

RF Terminal Cost/Unit	$ 56900	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-WEST	1	276		4090	50	1	1	1	0	56900	4500	20000	17000	35000	10000	89700	$ 233100
Colorado Mt.	1		15	7223	50	1	1	4	0	56900	4500	20000	17000	35000	40000	0	$ 173400
Thunder Bolt Mt.	1		17	8597	80	7	1	4	0	398300	31500	32000	35000	35000	40000	0	$ 571800
Boulder	1	14	18	4400	200	1	0	1	0	56900	4500	80000	17000	0	10000	4550	$ 172950
Deer Lodge	1	19	14	4521	40	1	0	1	0	56900	4500	16000	17000	0	10000	6175	$ 110575
Warm Springs/Galen	1	8	19	4420	40	1	0	1	0	56900	4500	16000	17000	0	10000	2600	$ 107000
Anaconda	1	19	28	5265	30	1	0	1	0	56900	4500	12000	17000	0	10000	6175	$ 106575
White Tail Peak	1		19	8475	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Butte	1	44	10	5549	40	1	0	1	0	56900	4500	16000	17000	0	10000	14300	$ 118700
Mount Fleecer	1		39	9436	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Dillon	1	18	44	5096	40	1	0	1	0	56900	4500	16000	17000	0	10000	5850	$ 110250
Henderson Mt.	1		43	7087	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Solomon Mt.	1		22	6916	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Miller Peak	1		13	7018	50	2	1	4	0	113800	9000	20000	20000	35000	40000	0	$ 237800
Hamilton	0	23	38	4100	30	1	0	1	0	56900	4500	12000	17000	0	10000	7475	$ 107875
Missoula	1	224	10	3227	40	1	0	1	0	56900	4500	16000	17000	0	10000	72800	$ 177200
Squaw Peak	1		36	7996	30	0	0	3	1	95000	0	12000	0	0	30000	0	$ 137000
White Clay Mt.	1		35	5680	30	2	1	4	0	113800	9000	12000	20000	35000	40000	0	$ 229800
Polson	1	15	31	3022	30	1	0	1	0	56900	4500	12000	17000	0	10000	4875	$ 105275
Blacktail Mt.	1		26	6757	30	0	1	2	1	95000	0	12000	0	35000	20000	0	$ 162000
Kalispell	1	35	16	3000	30	1	0	1	0	56900	4500	12000	17000	0	10000	11375	$ 111775
TOTALS										1878700	103500	420000	279000	210000	440000	225875	3557075

Total Route Cost For Former Tel Pak Points $ 3449200

STATE of MONTANA

LOW DENSITY

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave-Low Density
1997 System Quantities
Plan 2-East Route

RF Terminal Cost/Unit	$ 56900	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
HELENA-EAST	1	241		4090	50	1	0	1	0	56900	4500	20000	17000	0	10000	78325	$ 186725
Duck Creek Pass	1		38	7515	60	0	0	3	1	95000	0	24000	0	0	30000	0	$ 149000
Wolf Hill	1		36	6662	50	0	0	2	1	95000	0	20000	0	0	20000	0	$ 135000
No. Livingston Mt.	1		31	7964	60	4	1	3	0	227600	18000	24000	26000	35000	30000	0	$ 360600
Bozeman	1	108	14	4810	50	1	0	1	0	56900	4500	20000	17000	0	10000	35100	$ 143500
Livingston	0	21	12	4503	40	1	0	1	0	56900	4500	16000	17000	0	10000	6825	$ 111225
Conical Peak	1		28	10731	50	0	0	3	1	95000	0	20000	0	0	30000	0	$ 145000
Big Timber	1	14	28	3870	30	2	0	1	0	113800	9000	12000	20000	0	10000	4550	$ 169350
Lone Indian Butte	1		19	5197	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Antelope Point	1		28	4560	40	2	1	2	0	113800	9000	16000	20000	35000	20000	0	$ 213800
Blue Creek Rptr	1		29	4000	40	3	1	2	0	170700	13500	16000	23000	35000	20000	0	$ 278200
Billings	1	98	10	3124	50	1	0	1	0	56900	4500	20000	17000	0	10000	31850	$ 140250
Indian Creek Rptr	1		20	4204	40	0	0	1	1	95000	0	16000	0	0	10000	0	$ 121000
Pine Ridge	1		32	3777	50	2	1	1	0	113800	9000	20000	20000	35000	10000	0	$ 207800
Reservation Creek	1		40	3500	100	3	1	1	0	170700	13500	40000	23000	35000	10000	0	$ 292200
Forsyth	1	16	12	3200	30	1	0	1	0	56900	4500	12000	17000	0	10000	5200	$ 105600
Graveyard Creek	1		39	3000	150	3	1	1	0	170700	13500	60000	23000	35000	10000	0	$ 312200
Miles City	1	31	18	2500	40	1	0	1	0	56900	4500	16000	17000	0	10000	10075	$ 114475
Powder River Rptr	0		38	3343	180	2	1	1	0	113800	9000	72000	20000	35000	10000	0	$ 259800
Fallon Creek Rptr	0		26	2665	120	2	1	1	0	113800	9000	48000	20000	35000	10000	0	$ 235800
Glendive	0	90	29	2180	190	1	0	1	0	56900	4500	76000	17000	0	10000	29250	$ 193650
TOTALS										2182000	135000	584000	314000	280000	300000	201175	$ 3996175

Total Route Cost For Former Tel Pak Points $ 3195700

PLAN TOTAL: $12.106.050

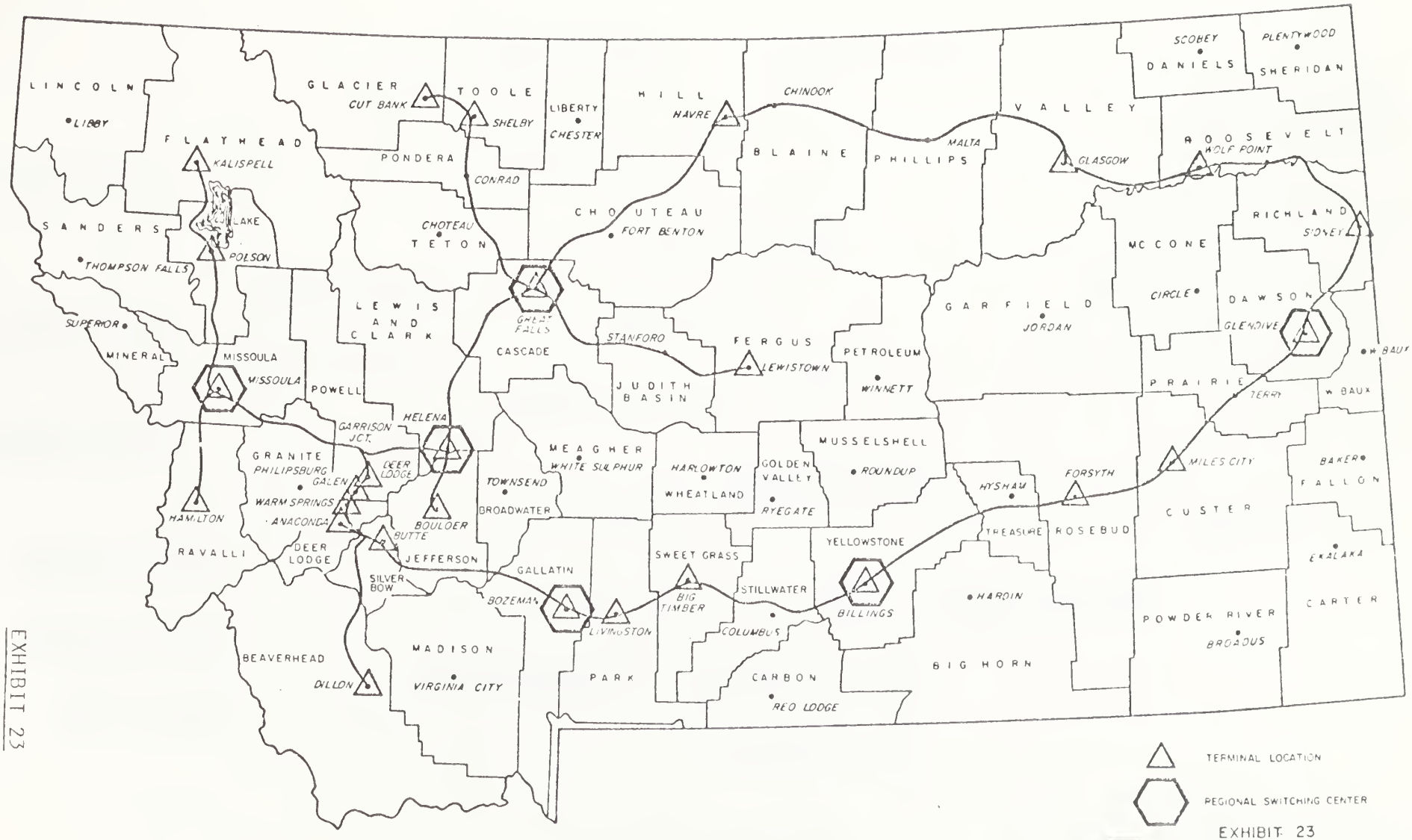


EXHIBIT 23

EXHIBIT 23

STATE OF MONTANA

FIBER OPTIC TRANSMISSION SYSTEM

EXHIBIT 24

REGIONAL SWITCHING CENTER

REG SW - SWITCHED TRUNKS FROM REGIONAL CENTER TO HELENA BASE

SW - SWITCHED TRUNKS FROM TERMINAL LOCATION OR LOCAL SWITCH

EXHIBIT 24

STATE OF MONTANA

TRUNKING DIAGRAM

FIBER OPTIC TRANSMISSION SYSTEM

STATE of MONTANA

FIBER OPTIC TRANSMISSION SYSTEM
1997 System Cost

Fiber Cable Cost/Fiber-M	.80
Sheath & Burial Cost/M	4.00
Repeater Cost/Fiber	12500.00
Multiplex Cost/DS-1	3000.00
Channel Cost/Channel	325.00

Section	Fmr Tel Pak	Technical Data Ckt Qty	Mi	# Fbr	# DS-1	# Rpt	Section Cost Cable	Rptr	MUX	Chn	Total Cost
Helena-Garrison Jct	1		46	8	32	24	769910	300000	96000	0	$ 1165910
Helena-Boulder	1	14	29	2	8	4	261357	50000	24000	4550	$ 339907
Garrison Jct-Deer Lodge	1	19	11	6	24		155784	0	72000	6175	$ 233959
Deer Lodge-Anaconda	1	19	11	6	24		155784	0	72000	6175	$ 233959
Anaconda-Dillon	1	18	67	2	8	10	603826	125000	24000	5850	$ 758676
Anaconda-Butte	1	44	30	5	20	10	386243	125000	60000	14300	$ 585543
Butte-Bozeman	1	51	85	5	24	30	1094354	375000	72000	16575	$ 1557929
Bozeman-Livingston	1	21	26	4	16	8	301269	100000	48000	6825	$ 456094
Livingston-Big Timber	1	14	36	4	16	8	417142	100000	48000	4550	$ 569692
Big Timber-Billings	1	98	84	4	16	24	973331	300000	48000	31850	$ 1353181
Billings-Forsyth	1	16	94	3	12	21	968181	262500	36000	5200	$ 1271881
Forsyth-Miles City	1	31	54	3	12	12	556189	150000	36000	10075	$ 752264
Miles City-Glendive	0	191	81	3	12	18	834284	225000	36000	62075	$ 1157359
Glendive-Sidney	0	22	55	3	12	12	566489	150000	36000	7150	$ 759639
Sidney-Wolf Point	0	18	93	3	12	21	957882	262500	36000	5850	$ 1262232
Wolf Point-Glasgow	0	29	52	3	12	12	535590	150000	36000	9425	$ 731015
Glasgow-Havre	0	26	161	3	12	36	1658268	450000	36000	8450	$ 2152718
Havre-Great Falls	1	186	115	3	12	27	1184477	337500	36000	60450	$ 1618427
Great Falls-Shelby	0	23	90	2	8	14	811109	175000	24000	7475	$ 1017584
Shelby-Cut Bank	0	14	26	2	8	4	234320	50000	24000	4550	$ 312870
Great Falls-Lewistown	1	34	108	2	8	16	973331	200000	24000	11050	$ 1208381
Great Falls-Helena	1	186	92	4	16	28	1066029	350000	48000	60450	$ 1524479
Garrrison Jct-Missoula	1	195	72	2	12	15	648888	187500	36000	63375	$ 935763
Missoula-Hamilton	0	23	48	2	8	8	432592	100000	24000	7475	$ 564067
Missoula-Polson	1	15	59	2	8	8	531727	100000	24000	4875	$ 660602
Polson-Kalispell	1	35	55	2	8	8	495678	100000	24000	11375	$ 631053
TOTAL							17574036	4725000	1080000	436150	$ 23815186

Total System Cost For Former Tel Pak Points $ 15857703

EXHIBIT 25

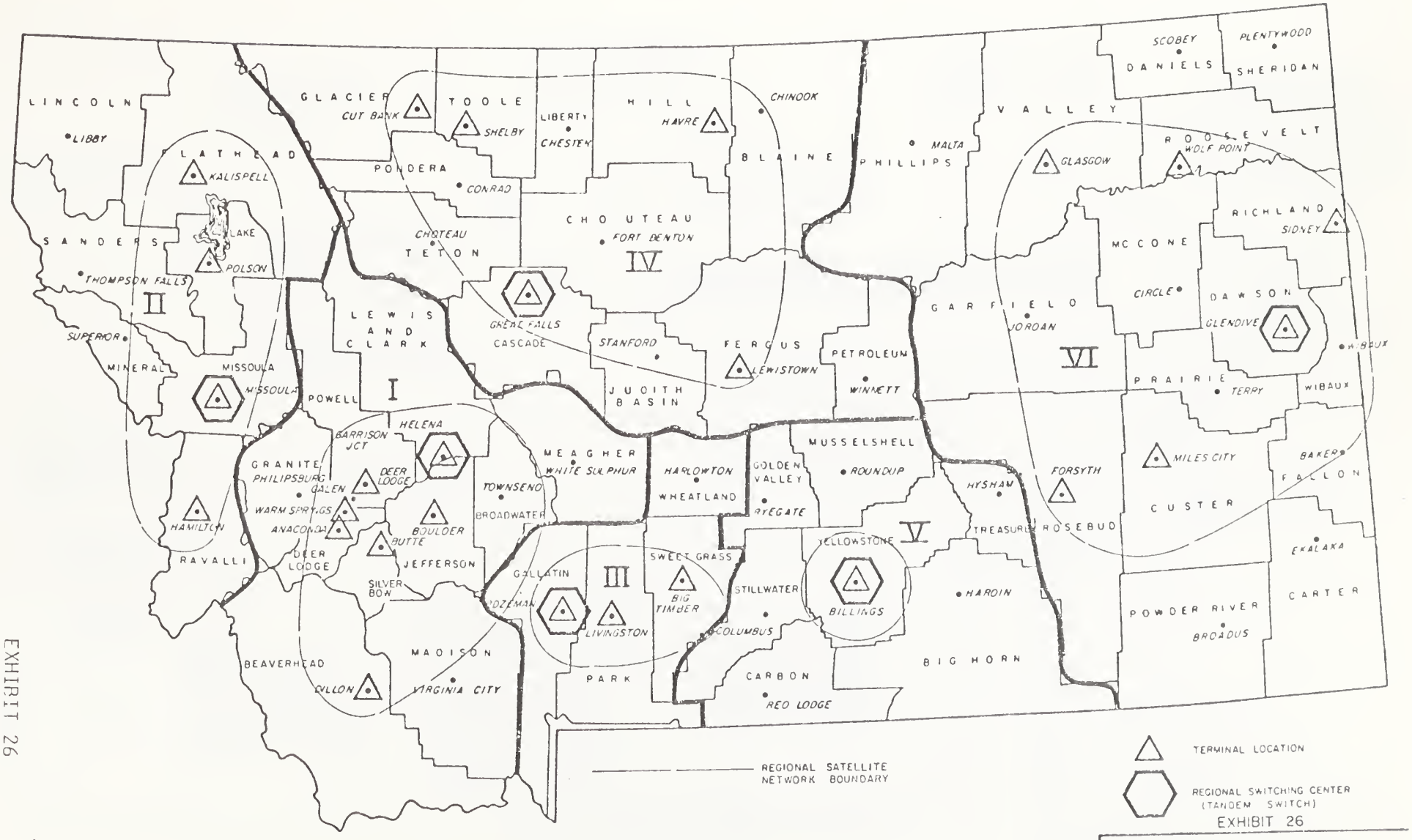


EXHIBIT 26

EXHIBIT 26

STATE OF MONTANA

PROPOSED

SATELLITE TRANSMISSION SYSTEM

STAR NETWORK DESIGN

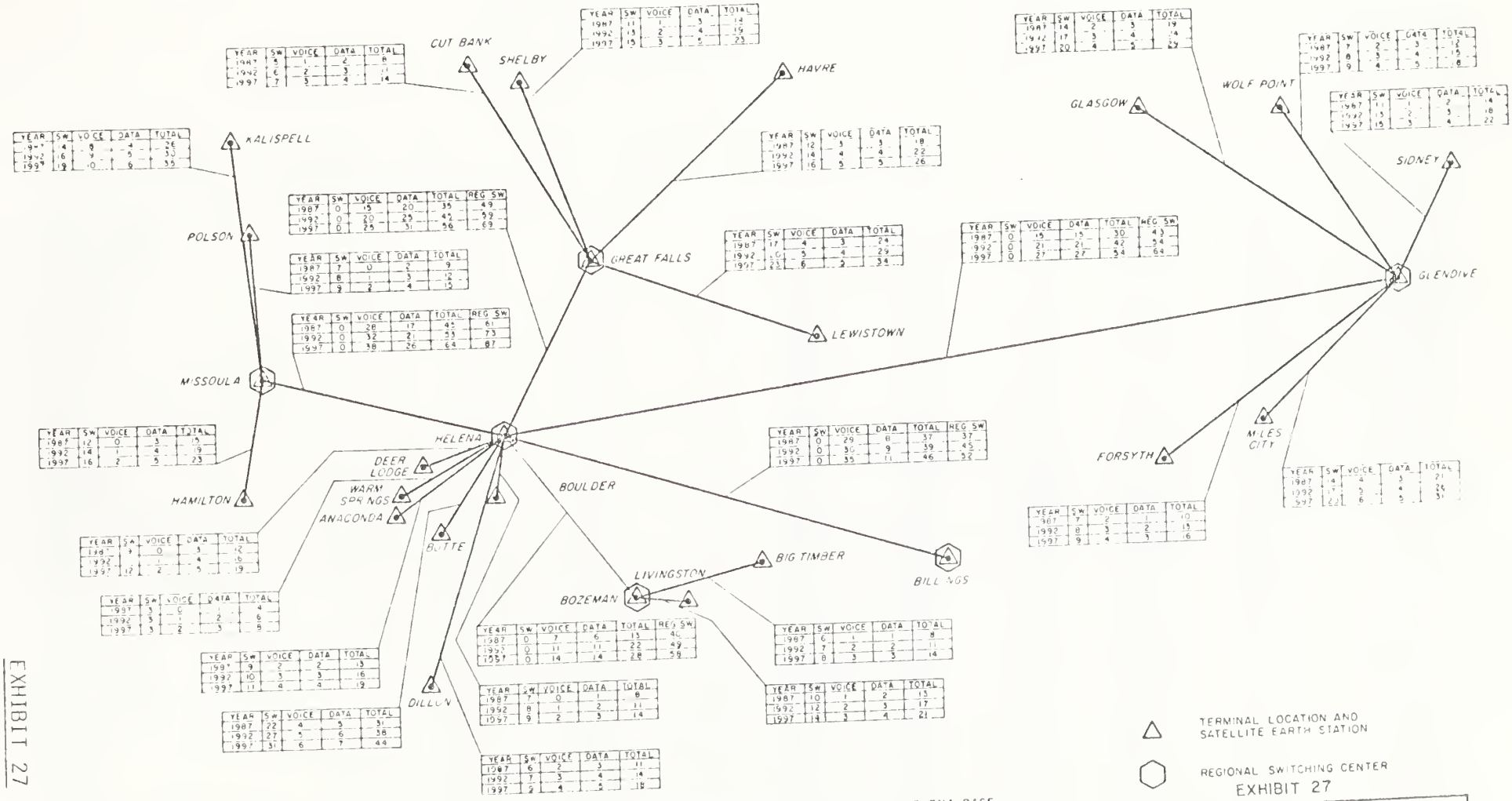

CUT BANK
SHELBY
HAVRE
KALISPELL
POLSON
GREAT FALLS
LEWISTOWN
GLASGOW
WOLF POINT
SIDNEY
GLENDIVE
MISSOULA
HELENA
DEER LODGE
WARM SPRINGS
ANACONDA
HAMILTON
BUTTE
BOULDER
BILLINGS
LIVINGSTON
BIG TIMBER
BOZEMAN
DILLON
FORSYTH
MILES CITY
REG SW - SWITCHED TRUNKS FROM REGIONAL CENTER TO HELENA BASE
SW - SWITCHED TRUNKS FROM TERMINAL LOCATION OR LOCAL SWTCH
TERMINAL LOCATION AND SATELLITE EARTH STATION
REGIONAL SWITCHING CENTER
EXHIBIT 27
STATE OF MONTANA
PROPOSED SATELLITE TRANSMISSION SYSTEM
TRUNKING PLAN

EXHIBIT 27

STATE of MONTANA

SATELLITE TRANSMISSION SYSTEM
Ground Segment Costs
Digital Satellite Plan
1997 System Quantities

TWT Cost/Watt	$ 500.00
RF Equipment Cost/Unit	$ 70000.00
Antenna Cost/Meter	$ 6000.00
D.C. Pwr Cost/Unit	$ 24000.00
Ctrl/Trk Equip Cost/Ckt	$ 4000.00
Building & Site Cost/Unit	$ 45000.00

Site	Former Tel Pak?	# Circuits	TWT Power	Ant Dia Meters	Costs: Antenna	RF Equip	DC Power	Ctrl/Trk	Building	Total
Anaconda	1	19	30	7	42000	85000	24000	76000	45000	$ 272000
Big Timber	0	14	30	7	42000	85000	24000	56000	45000	$ 252000
Billings	1	98	100	11	66000	120000	24000	392000	45000	$ 647000
Boulder	1	14	30	7	42000	85000	24000	56000	45000	$ 252000
Bozeman	1	62	100	11	66000	120000	24000	248000	45000	$ 503000
Butte	1	44	50	7	42000	95000	24000	176000	45000	$ 382000
Cutbank	0	14	30	7	42000	85000	24000	56000	45000	$ 252000
Deer Lodge	1	19	30	7	42000	85000	24000	76000	45000	$ 272000
Dillon	1	18	30	7	42000	85000	24000	72000	45000	$ 268000
Forsyth	1	16	30	7	42000	85000	24000	64000	45000	$ 260000
Glasgow	0	29	50	7	42000	95000	24000	116000	45000	$ 322000
Glendive	0	32	50	11	66000	95000	24000	128000	45000	$ 358000
Great Falls	1	53	75	11	66000	107500	24000	212000	45000	$ 454500
Hamilton	0	23	30	7	42000	85000	24000	92000	45000	$ 288000
Havre	1	26	50	7	42000	95000	24000	104000	45000	$ 310000
Helena	1	240	300	11	66000	220000	24000	960000	45000	$ 1315000
Kalispell	1	35	50	7	42000	95000	24000	140000	45000	$ 346000
Lewistown	1	34	50	7	42000	95000	24000	136000	45000	$ 342000
Livingston	0	21	30	7	42000	85000	24000	84000	45000	$ 280000
Miles City	1	31	50	7	42000	95000	24000	124000	45000	$ 330000
Missoula	1	97	100	11	66000	120000	24000	388000	45000	$ 643000
Polson	1	15	30	7	42000	85000	24000	60000	45000	$ 256000
Shelby	0	23	30	7	42000	85000	24000	92000	45000	$ 288000
Sidney	0	22	30	7	42000	85000	24000	88000	45000	$ 284000
Warm Springs/Galen	1	8	30	7	42000	85000	24000	32000	45000	$ 228000
Wolf Point	0	18	30	7	42000	85000	24000	72000	45000	$ 268000
TOTALS					1236000	2457500	600000	4024000	1125000	$ 9400500

Total System Cost For Former Tel Pak Points $ 6808500

EXHIBIT 28

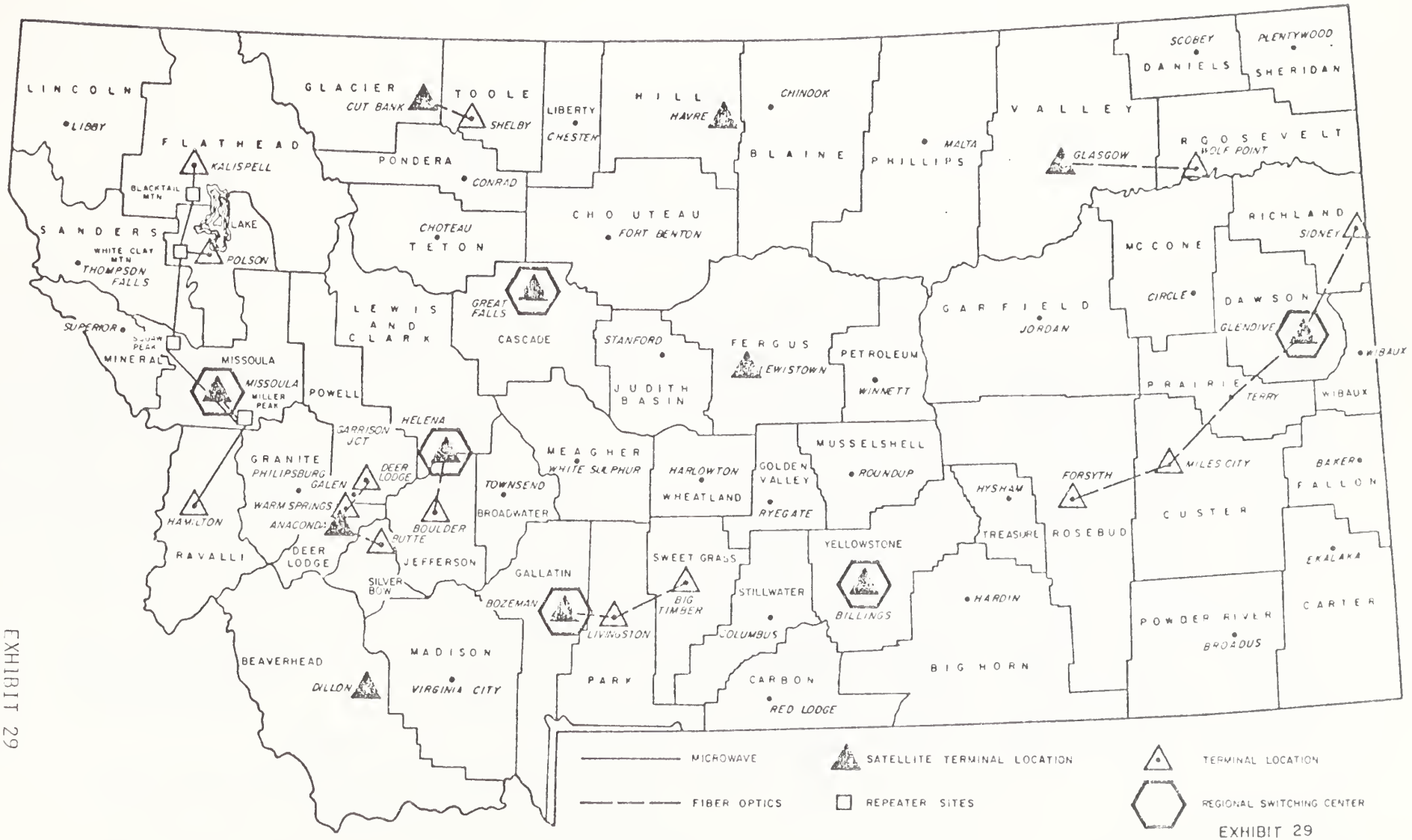


EXHIBIT 29

STATE OF MONTANA

PROPOSED TRANSMISSION SYSTEM

COMBINED TECHNOLOGY

EXHIBIT 29

STATE of MONTANA

FIBER OPTIC TRANSMISSION SYSTEM
-Combined Transmission Method-
1997 System Quantities

Fiber Cable Cst/Fiber-M	$ .80
Sheath & Burial Cost/M	$ 4.00
Repeater Cost/Fiber	$ 12500.00
Multiplex Cost/DS-1	$ 3000.00
Channel Cost/Channel	$ 325.00

Section	Fmr Tel Pak	Technical Data Ckt Qty	Mi	# Fbr	# DS-1	# Rpt	Section Cost Cable	Rptr	MUX	Chn	Total Cost
Deer Lodge-Warm Springs	1	27	16	2	2	0	144197	0	6000	8775	$ 158972
Warm Springs-Anaconda	1	27	10	2	2	0	90123	0	6000	8775	$ 104898
Butte-Anaconda	1	88	24	2	4	2	216296	25000	12000	28600	$ 281896
Big Timber-Livingston	1	35	37	2	2	2	333456	25000	6000	11375	$ 375831
Livingston-Bozeman	1	35	26	2	2	2	234320	25000	6000	11375	$ 276695
Shelby-Cut Bank	0	46	26	2	2	2	234320	25000	6000	14950	$ 280270
Wolf Point-Glasgow	0	36	52	2	2	6	468641	75000	6000	11700	$ 561341
Forsyth-Miles City	1	16	54	2	2	6	486666	75000	6000	5200	$ 572866
Miles City-Glendive	0	47	81	2	2	8	729998	100000	6000	15275	$ 851273
Sidney-Glendive	0	44	55	2	2	6	495678	75000	6000	14300	$ 590978
TOTAL							3433696	425000	66000	130325	$ 4055021

Total System Cost For Former Tel Pak Points $ 1771159

EXHIBIT 30
Page 1 of 3

STATE of MONTANA

SATELLITE TRANSMISSION SYSTEM
Ground Segment Costs
Digital Satellite Plan
-Combined Transmission Method-
1997 System Quantities

TWT Cost/Watt	$ 500.00
RF Equipment Cost/Unit	$ 70000.00
Antenna Cost/Meter	$ 6000.00
D.C. Pwr Cost/Unit	$ 24000.00
Ctrl/Trk Equip Cost/Ckt	$ 4000.00
Building & Site Cost/Unit	$ 45000.00

Site	Former Tel Pak?	# Circuits	TWT Power	Ant Dia Meters	Costs					
					Antenna	RF Equip	DC Power	Ctrl/Trk	Building	Total
Anaconda	1	17	100	7	42000	120000	24000	68000	45000	$ 299000
Billings	1	98	100	11	66000	120000	24000	392000	45000	$ 647000
Bozeman	1	86	100	7	42000	120000	24000	344000	45000	$ 575000
Cutbank	0	34	50	7	42000	95000	24000	136000	45000	$ 342000
Dillon	1	18	30	7	42000	85000	24000	72000	45000	$ 268000
Glasgow	0	43	50	7	42000	95000	24000	172000	45000	$ 378000
Glendive	0	119	50	7	42000	95000	24000	476000	45000	$ 682000
Great Falls	1	126	150	7	42000	145000	24000	504000	45000	$ 760000
Havre	1	26	50	7	42000	95000	24000	104000	45000	$ 310000
Helena	1	240	300	11	66000	220000	24000	960000	45000	$ 1315000
Lewistown	1	34	50	7	42000	95000	24000	136000	45000	$ 342000
Missoula	1	151	150	7	42000	145000	24000	604000	45000	$ 860000
TOTALS					552000	1430000	288000	3968000	540000	$ 6778000

Total System Cost For Former Tel Pak Points $ 4730500

EXHIBIT 30
Page 2 of 3

STATE of MONTANA

MICROWAVE TRANSMISSION SYSTEM
Digital Microwave
-Combined Transmission Method-
1997 System Quantities

RF Terminal Cost/Unit	$ 68600	Channel Equip/Circuit	$ 325
DC Pwr Supply Cost/Unit	$ 3000	RF Repeater Cost/System	$ 95000
Building Cost/Unit	$ 35000	Tower Cost/Ft	$ 400
Site Preparation Cost/Pt	$ 10000	Antenna System Cost/Ant	$ 4500
(DC Pwr Supply Base Cst	$ 14000)		

Site	Fmr Tel Pak ?	# Ckt Trm	Dst Mi	Elv Ft	Twr Hgt Ft	# RF Trm	Bldg 0/1	Pts Site Prep	RF Rpt 0/1	RF Equip	Ant	Tower	DC Power	Bldg	Site Prep	MUX Chns	Total
	---Technical Details---									---Extended Costs---							
Miller Peak	1		13	7018	50	2	1	4	0	137200	9000	20000	20000	35000	40000	0	$ 261200
Hamilton	0	23	38	4100	30	1	0	1	0	68600	4500	12000	17000	0	10000	7475	$ 119575
Missoula	1	73	10	3227	40	1	0	1	0	68600	4500	16000	17000	0	10000	23725	$ 139825
Squaw Peak	1		36	7996	30	0	0	3	1	95000	0	12000	0	0	30000	0	$ 137000
White Clay Mt.	1		35	5680	30	2	1	4	0	137200	9000	12000	20000	35000	40000	0	$ 253200
Polson	1	15	31	3022	30	1	0	1	0	68600	4500	12000	17000	0	10000	4875	$ 116975
Blacktail Mt.	1		26	6757	30	0	1	2	1	95000	0	12000	0	35000	20000	0	$ 162000
Kalispell	1	35	16	3000	30	1	0	1	0	68600	4500	12000	17000	0	10000	11375	$ 123475
TOTALS										738800	36000	108000	108000	105000	170000	47450	$ 1313250

Total Route Cost For Former Tel Pak Points $ 1228675

PLAN TOTAL: $12,146,271

EXHIBIT 30
Page 3 of 3

COST SUMMARY

ALTERNATIVE TRANSMISSION METHODS

	Microwave Plant II			Fiber Optics	Satellite	Combined Methods	
		Digital					
	Analog	Low Density	Medium Density				
West	$ 3,683,200	$ 3,557,075	$ 3,826,175	$23,815,186	$9,400,500 Ground Segment + 2,016,000 Space Segment Lease	Fiber	$ 4,055,021
East	3,851,600	3,996,175	4,347,175			Satellite - Ground Segment	6,778,000
North	4,057,400	4,552,800	4,938,900			Microwave	1,313,250
Total	$11,592,200	$12,106,050	$13,112,250			Total	$12,146,271
						Satellite - Space Segment Lease	$ 2,016,000

NOTE: In addition to the above costs, estimated annual maintenance expenses of six percent of installed costs would be required.

EXHIBIT 31

STATE OF MONTANA

LIST OF DEPARTMENTS AND

LOCATIONS OF FIELD OFFICES

Agriculture

Plant and Industry Division - Commodity Services Bureau

Billings	Hamilton
Butte	Kalispell
Great Falls	Polson
	Sidney

Plant and Industry Division - Grain Standards Bureau

Great Falls

Wheat Research and Marketing Unit

Great Falls

Technical Services Bureau

Lewistown

Rodent Control Specialist

Lewistown

Pesticide Specialist

Missoula

Environmental Library

Missoula

Environmental Management Division

Billings	Great Falls
Bozeman	Lewistown
Glasgow	Missoula

Agricultural Experiment Station

(See MSU)	Havre
Conrad	Hobson
Corvallis	Huntley
Creston	Kalispell
Hamilton	Moccasin
Harrison	Sidney

Extension Service

Sidney

Health and Environmental Sciences

Billings

Air Quality Bureau
Food and Consumer Safety Bureau
Material and Child Health
Water Quality Bureau
Preventive Health Bureau

Butte

Occupational Health Bureau
Preventive Health Bureau

Glendive

Health and Environmental Services Dept.

Great Falls

Heart Disgnostic Center

Kalispell

Air Pollution Control
Air and Water Quality Bureau

Missoula

Preventive Health Bureau

Fish, Wildlife and Parks

Game Warden

Augusta	Crane	Havre	Seeley Lake
Baker	Deer Lodge	Lewistown	Shelby
Belgrade	Dillon (2)	Libby (2)	Sheridan
Big Timber	Ennis	Lincoln	Stanford
Broadus	Eureka	Livingston (2)	Stevensville
Butte (2)	Forsyth	Malta	Superior
Cascade	Fort Benton	Philipsburg	Thompson Falls
Chinook	Glendive	Plentywood	Townsend
Choteau	Hamilton	Polson	W. Yellowstone
Circle	Hardin	Red Lodge	Whitefish
Columbus	Harlowton	Roundup	White Sulphur Springs

Headquarters

Bozeman	Miles City - Office
Glasgow - Office	Missoula
Kalispell - Office	

Other

Madison Wall Creek Bunk House	- Ennis
Madison Wall Creek Game Range	- Ennis
Freezeout Lake Headquarters	- Fairfield
Bluewater Fish Hatchery	- Fromberg
Sun River Game Range	- Augusta
Fish Hatchery	- Big Timber
Wildlife Research Bureau	- Bozeman
Bitterrout Game Range	- Corvallis
Blackfoot-Clearwater Game Range	- Orvando
Fish Hatchery	- Great Falls
Judith Game Range	- Hobson
Fish Hatchery	- Lewistown
Fish Hatchery	- Libby
Wildlife Division	- Townsend
Game Farm	- Whitehall
Shop	- Whitehall
Lewis & Clark Caverns	- Ovando

Highways

Maintenance Shops

Alberton
Anaconda
Ashland
Augusta
Baker
Basin
Beaverslide
Belt
Big Sandy
Big Sky
Big Timber
Boulder
Boyes
Broadus
Browning
Busby
Cascade
Chester
Choteau
Circle
Columbia Falls
Conrad
Creeks Camp
Crystal Creek
Custer
Cut Bank
Deep Creek
Deer Lodge - (Garage)
Denton
Dillon - (Garage)
Divide
Drummond
Dupuyer
Dutton
Ennis
Fairfield
Fiddleback
Flowing Wells
Forsyth
Fort Benton
Glasgow
Grass Range
Hamilton
Harlem
Harlowton
Harrison - (Garage)
Hillside
Hot Springs
Hysham
Libby
Lima
Lincoln
Lodge Grass
Malta
Mobridge
Noxon
Nyack
Opheim
Philipsburg
Plains
Plentywood
Polson
Rainy Lake
Ravalli
Ronan
Roundup - (Garage)
Roy
Ryegate
Saint Mary
Saltest
Ingomar
Scobey
Seely Lake
Sidney
Stanford
Summit
Sunburst
Sun River
Superior
Terry
Thompson Falls
Three Forks - (Garage)
Townsend
Troy
Twin Bridges
Whitehall - (Garage)
White Sulphur Springs - (Garage)
Wibaux
Wilsall
Winnett
Wisdom - (Garage)
Wolf Creek

Division Offices

Billings
Bozeman
Butte
Glendive
Great Falls
Havre
Kalispell
Lewistown
Miles City
Missoula
Wolf Point

Weigh Stations

Bonner
Bozeman
Butte
Circle
Columbia Falls
Crow Agency
Crystal Creek
Drummond
Forsyth
Frenchtown
Great Falls (2)
Harlowtown
Kalispell
Libby
Lima
Lolo
Missoula
Seely Lake
Swan Lake
Wibaux

Section Houses

Duck Creek (W. Yellowstone)
Gallatin Gateway

Field Construction Office

Hobson

Institutions

Mental Health Center

Anaconda	Dillon	Great Falls	Ronan
Big Timber	Harlowton	Hamilton	Roundup
Chester	Lewistown	Hardin	Seely Lake
Chinook	Malta	Havre	Shelby
Choteau	Billings	Kalispell	Sidney
Columbus	Butte	Lincoln	Superior
Conrad	Forsyth	Miles City	Thompson Falls
Cut Bank	Glasgow	Missoula	Wolf Point
Denton	Glendive	Red Lodge	

Community Correction Bureau

Anaconda	Deer Lodge	Great Falls	Libby
Billings	Forsyth	Hamilton	Lincoln
Bozeman	Glasgow	Havre	Miles City
Butte	Glendive	Kalispell	Missoula
			Polson

Other

Boulder River School	- Boulder
Veterans' Home	- Columbia Falls
Board of Pardons	- Deer Lodge
Montana State Prison	- Deer Lodge
Financial Investigator	- Galen
Galen State Hospital	- Galen - See Warm Springs
Center for the Aged	- Lewistown
Pine Hills School	- Miles City
Youth Evaluation Program	- Great Falls
Swan River Youth Forest Camp	- Swan Lake
Warm Springs State Hospital	- Warm Springs
Women's Facility	- Warm Springs

Justice Department

Highway Patrol/Driver Exam

Billings	Butte	Kalispell	Missoula
Bozeman	Great Falls	Lewistown	

Board of Crime Control

Anaconda	Billings	Great Falls	Missoula

Fire Marshal Bureau

Billings	Chinook	Glendive	Missoula

Other

Law Enforcement Services Division - Law Enforcement Academy - Bozeman

Registrar's Bureau	- Deer Lodge
Forensic Sciences Division	- Missoula
Laboratory of Criminalistics	- Missoula

Labor and Industry

Job Service

Anaconda	Dillon	Kalispell	Polson
Billings (2)	Glasgow	Lewistown	Shelby
Bozeman	Glendive	Libby	Sidney
Browning	Great Falls	Livingston	Thompson Falls
Butte	Hamilton	Miles City	Wolf Point
Cut Bank	Havre	Missoula	

Other

Labor Standards Division - Apprenticeship Bureau/Standards Bureau/ Training/ Compliance Officer - Billings

Lands, State Department of

Forestry Division

Anaconda	Garrison	Kalispell	Missoula
Billings	Greenough	Lewistown	Plains
Bozeman	Hamilton	Libby	Swan Lake

Reclamation Division - Billings
Office - Glasgow

Military Affairs

Guard Companies

Anaconda	Deer Lodge	Harlowtown	Malta
Billings	Dillon	Havre	Miles City
Bozeman (2)	Glasgow	Kalispell	Missoula (3)
Butte	Great Falls	Lewistown	Plentywood
Chinook	Glendive	Libby	Shelby
Culbertson	Hamilton	Livingston	Sidney
			Whitefish

Organizational Maintenance Shop

Belgrade	Chinook	Kalispell	Missoula
Billings	Culbertson		

Reserve

Billings	Glendive	Great Falls	Missoula
Bozeman			

Natural Resources

Tongue River Dam - Birney - Ashland
Oil & Gas Conservation District - Sidney, Billings, Glendive, Shelby
Water Rights Bureau - Billings, Bozeman, Glasgow, Havre, Lewistown, Miles City, Missoula
Daly Ditches Projects - Hamilton
Weather Notification - Miles City

Revenue

County Appraiser
County Assessor

Anaconda	Cut Bank	Jordan	Shelby
Baker	Deer Lodge	Kalispell	Sidney
Big Timber	Dillon	Lewistown	Stanford
Billings	Ekalaka	Libby	Superior
Boulder	Forsyth	Livingston	Terry
Bozeman	Fort Benton	Malta	Thompson Falls
Broadus	Glasgow	Miles City	Townsend
Butte	Glendive	Missoula	Virginia City
Chester	Great Falls	Plentywood	Warm Springs
Chinook	Hamilton	Polson	Wibaux
Choteau	Hardin	Red Lodge	Winnet
Circle	Harlowton	Roundup	Wolf Point
Columbus	Havre	Ryegate	Helena
Conrad	Hysham	Scobey	Phillipsburg

State Liquor Stores

Anaconda	Cut Bank	Harlowtown	Ronan
Ashland	Deer Lodge	Havre	St. Ignatius
Baker	Dillon	Kalispell (2)	Scobey
Belgrade	Drummond	Laurel	Shelby
Big Fork	Ennis	Lewistown	Sheridan
Big Timber	Eureka	Libby	Sidney
Billings (4)	Forsyth	Lincoln	Thompson Falls
Bozeman (2)	Fort Benton	Livingston	Three Forks
Browning	Frenchtown	Malta	Townsend
Butte (2)	Gardiner	Miles City	Troy
Chester	Glasgow	Missoula (2)	Victor
Choteau	Glendive	Philipsburg	Walkerville
Colstrip	Great Falls (3)	Plentywood	W. Yellowstone
Columbia Falls	Hamilton	Polson	Whitefish
Columbus	Hardin	Poplar	Whitehall
Conrad	Harlem	Red Lodge	Warm Springs
			Wolf Point

Child Support Enforcement Bureau

Billings	Butte	Great Falls	Missoula

Income Tax Division

	Billings	Missoula	

Investigation Division

Billings	Glasgow	Miles City	Missoula
Butte	Great Falls		

Social and Rehabilitation Services

Offices

Billings	Crow Agency	Havre	Miles City
Boulder	Deer Lodge	Kalispell	Missoula
Bozeman	Glasgow	Lame Deer	Poplar
Browning	Glendive	Lewistown	Shelby
Butte	Great Falls	Livingston	Wolf Point
			Warm Springs

University System

Agricultural Experiment Station - (MSU) Bozeman
Montana Tech - Butte
Cooperative Extension Service - Bozeman
Eastern Montana College - Billings
Montana State University - Bozeman
Northern Montana College - Havre
University of Montana - Missoula
Western Montana College - Dillon

Miscellaneous

District Judges - Billings
Economic Opportunity - Billings, Great Falls, Missoula
Roundup
Horticulture Inspection & Quarantine Service - Butte
Montana Drug Program - Butte
Montana Bureau of Mines and Geology - Butte
Vocational Technical Center - Butte, Great Falls
Commerce Department
Board of Pharmacists - Great Falls
Board of Public Education
School for the Deaf and Blind - Great Falls
Fire Services Training School - Great Falls
Flathead Valley Community College - Kalispell
Board of Education - Montana Historical Society - Libby
Governor's Office - Legal Jurisdiction Project - Missoula

ERRATA

ADDITIONS:

-Appendix A:

Livestock

Brand Inspection and Market Offices

Baker	Great Falls (2)
Billings (2)	Harlowton
Bozeman	Kalispell
Boulder	Lewistown
Chinook	Malta
Choteau	Miles City
Columbus	Missoula
Dillon	Shelby
Glasgow	Sidney
Glendive	

Predator Control

- Lewistown
- Miles City

Milk and Egg Bureau

- Billings
- Bozeman
- Great Falls
- Missoula

District Veterinarian

Billings	Miles City
Bozeman (2)	Ronan
Great Falls	Wolf Point
Lewistown	

Animal Health Division Diagnostic Lab

- Bozeman

Natural Resources

Water Rights Bureau

- Kalispell

MODIFICATIONS:

-Exhibit 4:

Department	Number of Field Offices	Field Offices-Description
Livestock	36	21 Brand Inspection Offices 8 District Vets 4 Milk & Egg Bureau

MODIFICATIONS: (Cont'd.)

		2 Predator Control
		1 Miscellaneous
Natural Resources	13	4 Oil and Gas Conserv. District
		8 Water Rights Bureaus
		1 Miscellaneous

DELETIONS:

-Appendix A:

Natural Resources
Daly Ditches Projects
Weather Notification

Change TOTAL at end of Appendix A to 623.

Change total field offices in first paragraph of Section II, page 4 of the Narrative, to 623 field offices.

APPENDIX D

DEPARTMENT OF HIGHWAYS

COMMUNICATIONS BUREAU

PROPOSED STATE HI-BAND SYSTEM

APPENDIX D

Department of Highways Communications Bureau
Proposed State Hi-Band System

In the interest of better service to the people of Montana, faster reporting of road information, weather conditions, response to emergencies and disasters, it becomes very apparent that the State of Montana is desperately in need of a much better communications system. A realistic approach toward this would be to revamp the Department of Highways system and build it as a backbone system, adding other agencies as funding can be made available to convert them to a High Band system. This is the most realistic and economical approach to a statewide communications system.

A statewide mobile communications system is becoming more necessary by the day. We need a statewide system to be able to meet the requests of the public and gather information relating to the various functions of State government. Many State agencies gather information on a daily basis and some agencies are constantly updating information to the State computer.

Over the past 30 years the Department of Highways has worked hard at developing a statewide two-way radio network to be used in its day to day operations and during adverse weather conditions and local disasters. We have had to work with unrealistic budgets and improvise in many ways to get where we are today; our present system is the result of hard work by many present and former employees of the Department.

The present system is still using some of the equipment that was purchased with the first funds that were appropriated in 1948 and 1949. Most electronic equipment is not designed for that type of usage or life expectancy. Normally 10 years is the maximum life expectancy of mobile two way radio equipment. At the present time almost 50% of the Department of Highways' mobile radios are 10 to 18 years old. This means an outlay of almost 50% of the total cost of the mobile category just to stay within the 10 year depreciation program.

Since the upgrading of the present system is very time consuming, it will very likely take two years to complete either the upgrading work or the changeover work. In this case, the low band radios that are presently 9 or 10 years old will require replacement by the time the upgrading process is completed.

If the cost of these radios is added to the cost of the upgrading, it becomes more apparent that upgrading the rather obsolete present system will be throwing more good money after bad. This money could be much more wisely spent on a high band

system that would not need any replacement for 8 to 10 years, and be much more reliable in the meantime. The base stations in the system are in as bad, or worse, situation than the mobiles.

Instead of replacing this much equipment with the same type equipment, we are proposing to make a major change in the complete system which will give the Department of Highways a better overall system and lead the way to what should eventually become a very versatile State communications system.

Due to the electrical characteristics of low band two way radios, it is impossible to spread frequencies far enough to include more than 1 or 2 agencies in one radio under the present low band system. Therefore, we propose the Department of Highways convert its present low band system to a high band system. This will allow sheriffs, city police and school buses, etc., to communicate with one another when the agencies go high band. This in effect will increase the number of public vehicles available to help in cases of emergency. This is an invaluable requirement during a disaster or for the purposes of coordination during a local or national emergency. In the past we have had emergencies of many natures where a highway truck and a highway patrolman were within 5 or 6 miles or less of each other and could not communicate because of the inability of the low band radio to have wide enough frequency spread to accommodate both users.

Other reasons for converting to high band are the immunity to pulse type noise such as spark plug noise, rotating beacons, flashing warning lights and a wider frequency range. Skip interference is much less on high band.

Many control circuits presently used by the Highways' radio network will not be relicensed by the FCC after one year. This means that a sizeable sum of money will have to be spent just to stay legal. The reasons for non-renewal of these licenses are rather unique in that they were set aside by the FCC for use as base and repeater use. But the FCC has gotten much more particular about their procedures and as a result, have advised users of these frequencies that they must move off of them to other control and repeater frequencies, preferably in the UHF channels, 450 MHz to 470 MHz.

This also means we must purchase new equipment in order to comply with the rules of the FCC because the present control and repeater radios cannot be converted to the UHF frequencies. Conversion to a high band system will alleviate most of this problem since we could use these frequencies as mobile relays which are legal and licensable by the FCC. Also, the present high band repeater radio can be used with modifications.

Radio sites are another issue and should be selected very carefully to avoid duplication of State facilities at the same location. These sites should be controlled by the State to eliminate involvement with private individuals or organizations

seeking to capitalize on the State's needs. Sites should be chosen to render the most service to agencies involved in the area of the site chosen. Also sites should be chosen with expansion of the system in mind in order to eliminate possible duplication or future expenses.

Since the State of Montana is the third largest in the continental U.S. and is very sparsely populated, it is imperative that statewide communications be as effective as possible. Many of the counties are converting to high band which will in turn put an undue burden on State agencies by requiring those agencies who are low band to carry two radios to be able to communicate with the counties. Since the counties have already started to go high band, it seems reasonable to assume that the Department of Justice within State government will have to go high band also, since they use county facilities almost on a daily basis.

The National Law Enforcement frequency is 155.475 MHz (high band) and according to the Associated Public Safety Communications Officials' national magazine, August, 1980 issue, Montana is scheduled to adopt that frequency in 1984. This being the case, the Highway Patrol will be required to comply.

Considering all these reasons, it would be in the State's best interest to devise a plan whereby the State, counties and cities could all use the same band of frequencies (namely: high band) in order to be able to communicate in a much more effective manner. Some State agencies are already in the high band frequencies: State Forestry Division, Emergency Medical Service and some smaller agencies. These agencies would fit into this overall State plan with very little expense to these agencies.

The Department of Highways is the largest State organization using a two way radio communications network and as such, is the most likely department to take the initiative toward a high band system. It has the engineering staff and maintenance personnel to develop and implement such a plan. The Department of Highways has made plans to initiate such a proposal and has done considerable preliminary work such as high band radio coverage surveys and frequency selection. High band frequencies are fast becoming used up and control of these frequencies is becoming harder to achieve.

APPENDIX E

HIGH BAND PILOT PROJECTS

APPENDIX E

HIGH BAND PILOT PROJECTS

I. BACKGROUND

A. Scope of Pilot Project

The Highway Patrol, with assistance from the Communications Division as spelled out in a matching fund agreement and technical assistance from the Department of Highways, Communications Bureau, is using high band funds to convert their Great Falls division from the present low band system to high band. Additionally, the Patrol is including the Helena area for central dispatching capabilities. The Highway Patrol pilot system's area of coverage is planned to encompass the general area from Browning to Chinook on the north extremities and Geyser to Lincoln on the south. Great Falls will be the central control point with dispatching capabilities out of Helena.

As requested by the 1981 Legislature, the Department of Highways has jointly participated in the Patrol's pilot program for implementing a new high band system. In addition to that pilot system, the Highway Department has developed and implemented a high band system of their own in the Great Falls district. The area of coverage is similar to that planned for the Patrol's pilot project.

B. Legislation

Section 2 of HB 827 (L.1981) contingently appropriated to the Department of Administration, Communications Division, the sums of $42,191 for fiscal year 1982 and $53,269 for fiscal year 1983 for state-wide telecommunications planning and related equipment purchases to the extent the Department receives dollar for dollar matching funds from other executive branch agencies. HB 500 (L.1981) appropriated $42,000 in FY-82 and $25,000 in FY-83 for purchase by the Highway Patrol of high band radio equipment. $98,000 was appropriated for the purchase of radio equipment by the Department of Highways.

C. Agreements

In consideration of the mutual benefits to each party, the Department of Justice, Highway Patrol, and the

Department of Administration, Communications Division, have agreed to appoint the Communications Division as the Highway Patrol's purchasing agent for the high band radio equipment for which the legislature has made a specific line-item appropriation in HB 500. As purchasing agent for the Highway Patrol, the Communications Division shall have authority to make claims for disbursements from the monies appropriated by HB 500 for radio equipment. The Highway Patrol remains the legal owner of the purchased radios and any other communication equipment purchased with the matching funds. The control of the matching funds was transferred from the Highway Patrol to the Communications Division for FY-82 and FY-83.

A similar agreement has been reached with the Department of Highways, Communications Bureau for FY-83. The control of the matching funds has been transferred from the Department of Highways to the Communications Division for FY-83.

D. Matching Funds

Based on the agreements mentioned above and the line-item appropriations in HB-500, a match of $42,000 was secured from the Department of Justice, Highway Patrol for FY-82. Additional matches of $25,000 from the Highway Patrol and a minimum of $20,000 from the Department of Highways have been secured for FY-83 based on the same agreements and HB 500 line-item appropriations.

II. FY-82 Assessment

A. Highway Patrol

1. Based on a general system plan, frequency coordination began in September, 1981. The frequencies applied for were 154.920, 155.550, 155.475 and 153.815 MHz. A coordination problem was encountered regarding one of the frequencies (153.815 MHz). This particular frequency had been chosen as a statewide local government mutual aid frequency which would fit into the State's plan to provide mutual aid frequencies on a statewide basis for interagency communications in emergency situations. After some delays the State Communications Division was unable to obtain this frequency. Thus, frequency coordination for a substitute local government mutual aid frequency began in June, 1982. The substitute frequency requested was 153.905 MHz. This frequency was licensed to the State in September, 1982.

Coincidental with the frequency coordination process, equipment orders were placed using system block diagrams that were often subject to revision. Such system changes were often followed by additional equipment orders.

An equipment ordering procedure was drawn up and distributed to all participants in the program. Control over the matching fund was gained and system plans were more definitively established.

2. Equipment Expenditures (Matching Funds)

INITIAL BALANCE		$42,000.00
Less:		
20 mobile radios	21,380.00	
1 desk top base	1,155.00	
2 mobile relays	5,422.00	
2 duplexers	1,450.00	
crystals*	3,426.04	
2 antennas	302.02	
6 UHF mobile radios	4,560.00	
4 UHF duplexers	1,440.00	
4 UHF antennas	255.00	
2 antenna mounts	88.00	
1 antenna	134.00	
crystals	128.34	
cabling and conv. kits	536.00	
7 antennas	1,440.76	
crystals	173.70	
antenna mounting kit	107.34	
connector component	1.80	42,000.00
BALANCE AS OF JUNE 30, 1982.....		0

*Of the expenditures for crystals, $3426.04 came out of FY-82 matching funds. The remainder ($1,765.96) will come out of FY-83 match.

3. Conclusion

In consultation with the Highway Patrol, a management plan was developed, combining the efforts of the Communications Division (program management) Department of Highways (technical support) and the Highway Patrol (physical installation). As Fiscal Year 1982 closed, the Highway Patrol's project was well underway.

B. Department of Highways

1. Project Status

The necessary frequency coordinations were

started the first week of October, 1981. This was completed and applications made to the F.C.C. the first week of December 1981. Final licenses were received during the latter part of April, 1982.

As soon as the funding policies were clarified in November, 1981, equipment was ordered. The equipment ordered was as versatile as possible considering this was to be a study program and possible changes in technical format required radios of flexible configuration. The new equipment was received in February, 1982.

Using the services of the highway radio personnel from Helena and Lewistown, the conversion of the Great Falls division proceeded smoothly and rapidly. The removal of old low band radios and the installation of the new high band mobiles was accomplished during February and March of 1982. Some problems were encountered during installation at a remote base station site due to foul weather conditions.

The new high band system has been operational since March. With the exception of a few minor technical problems, the system was operating satisfactorily at the end of FY-82.

2. Equipment Expenditures

INITIAL BALANCE.....		$98,000.00
Less:		
65 mobile radios	72,000.00	
2 mobile relays	5,422.00	
2 base station radios	3,421.00	
3 antennas	507.70	
2 duplexers	1,102.50	
cabling & antenna mounts	720.62	
3 hand held radios	2,979.00	86,172.81
BALANCE AS OF JUNE 30, 1982.....		$11,817.18

3. Conclusion

With proper coordination, a definitive initial working plan, and adequate manpower, the Department of Highways was able to convert their Great Falls division radio system to a functional high band system. A few minor technical problems remained unresolved at the end of FY-82.

III. FY-83 ASSESSMENT AND PLANS

A. Highway Patrol

1. Project Status

The high band pilot project will consist of one control station in Great Falls; 3 repeater/mobile relay stations located at Belt Butte, Rogers Pass (Sunset Mtn.), and Sweetgrass Hills (Mt. Royal); numerous mobile units; and a dispatching capability out of Helena utilizing the MacDonald Pass base station site.

At the Belt Butte repeater site, a tower, antenna and mobile relay station have been installed since the 1st of September. This relay station is now on the air providing service to mobiles in the Great Falls area. The station is equipped with battery backup which, in case of power failure, will be sufficient to operate the equipment for approximately one week of normal use. The station will transmit on 154.920 MHz and receive on 155.550 MHz with a sub-audible tone of 146.2 Hertz.

A mobile relay station radio was installed in August, 1982, at the Sweetgrass Hills site. This station is set up to transmit on 154.920 MHz and receive on 155.550 MHz with a tone of 156.7 Hertz. With a commercial standby power generator available, battery backup is not necessary at this station.

The last of the three repeater/mobile relay stations was installed at the Rogers Pass site the first week of September. With a sub-audible tone of 151.4 Hertz, this station will receive on 155.550 MHz while transmitting on 154.920 MHz. This site will use battery backup power similar to the Belt Butte installation. Since this site is leased by Bouma Postyards of Lincoln, Montana, a rental agreement had to be reached with the State and the lessor of the site. The agreement is being finalized at this time and will be in effect the 1st of October, 1982.

The control station is located in the district headquarters of the Highway Patrol at Great Falls. This station transmits on 154.920, and 155.550 MHz. The control site has been operational since July and, with the multi-tone encoder installed the first week of September, can access the Belt Butte and Sweetgrass Hills relay stations. The Sweetgrass connection is not always satisfactory but will be improved vastly when the planned UHF links are installed.

At the present time all the patrol cars used in the Great Falls and Helena areas have high band mobile radios installed in them. These radios are equipped with 3 channels.

The radio station licenses (155.550 and 154.920 MHz) have been approved and released by the F.C.C. All but one of the requested frequencies have been licensed. The national law enforcement mutual aid frequency (155.475 MHz) was not approved by the F.C.C. due to alleged interference with Royal Canadian Mounted Police frequencies in use in the provinces of Alberta and Saskatchewan. Since this frequency is currently being used by the states of North Dakota and Washington, the Communications Division is attempting to deal directly with Canada in resolving this frequency coordination problem.

The local government mutual aid substitute frequency (153.905 MHz) has also been approved and licensed by the F.C.C.

The console necessary for the desired dispatching capability out of Helena has been received and was installed in October, 1982. The MacDonald Pass site is operational.

2. Equipment Expenditures (Matching Funds)

INITIAL BALANCE		$25,000.00
Less:		
5 encoders	172.75	
15 decoders	599.25	
1 notch filter	24.95	
1 control console	8,412.68	
2 cable kits	100.00	
2 antennas	225.38	
antenna mounting brackets	31.13	
radio tower	1,900.00	
circulator	213.00	11,679.14
BALANCE AS OF OCTOBER 1, 1982.....		$15,433.86

3. Conclusion

To date in FY-83, the Highway Patrol's pilot program has progressed rapidly with 85% of all hardware installations being complete. Some testing has begun between the repeater locations and the control station.

A definitive system technical plan is being developed and future testing should provide enough data to devise a thorough technical scheme that could prove useful in any further expansion of high band conversion.

4. Plans for the Remainder of FY-83

With the basic system hardware in place, the only

remaining tasks involve installation of UHF control links, some additional equipment, and a complete system operational evaluation.

Most of the equipment necessary for operation of the basic system has been ordered. Any additional expenditures will occur as needs arise during system operational evaluation. Test equipment necessary to maintain and support the high band radios will also have to be purchased.

B. Department of Highways

1. Project Status

From the first days of operation additional planning and technical system refinement has been taking place designed to result in a more complete technical plan and a more efficient operating system. The basic high band system has undergone no system hardware change to date in FY-83. Mobile radios have been ordered to fill out the mobile radio complement in the Great Falls Division high band project. Additional channel elements have also been ordered for the common mutual aid channel.

2. Equipment Expenditures (Matching Funds)

INITIAL BALANCE.....		$20,000.00
Less:		
10 mobile radios	12,810.00	
67 T/R frequency elements	2,881.00	15,691.00
BALANCE AS OF OCTOBER 1, 1982.....		$ 4,309.00

3. Plans for Remainder of FY-83

Equipment funds will be committed to refining operations within the Great Falls Division as well as preparing control link systems which will be designed to replace existing control links currently in need of replacement and interface with future high band implementation plans.

IV. RECOMMENDATIONS

Several improvements, based on initial pilot project experiences, are suggested for future project expansion. Such improvements would enhance the land/mobile radio communications capabilities while streamlining the implementation process and minimizing some of the expense of high band conversion.

After frequencies are chosen and frequency coordination has begun, a definitive technical plan with detailed system

design based on the goals and objectives of the project is a critical initial stage necessary in any proposed communications system change and implementation. The goals and objectives are, of course, based on the ultimate user needs. Also included in such a plan are manpower needs, equipment needs and costs, and system implementation schedules.

After the initial planning is completed, some testing of the plan's technical validity should be done. Remote base station/repeater sites can be field tested to gain a more accurate picture of projected areas of coverage. Propagation studies and site surveys should be included in the evaluation of the site selections. Any necessary plan revisions should be made and additional sites evaluated until the feasibility of the technical plan is definite. This type of feasibility study would help to control costs by reducing additional equipment expenditures needed to modify or adjust the general system plan after hardware installation. After frequency coordination has begun and the feasible technical plan has been developed, then equipment should be ordered.

The following outline (one essentially used by the Department of Highways in their high band project) presents a strategy that could prove useful in the expansion of high band radio conversion:

I. Definitive goals and objectives based on ultimate user needs.

II. Definitive technical plan based on goals and objectives:

- -choice of frequencies
- -thorough frequency coordination
- -detailed system design
- -equipment needs and costs
- -manpower needs
- -system implementation schedules

III. Preliminary testing of technical validity of plan:

- -propagation studies of base station/repeater sites
- -site surveys
- -field testing of sites
- -plan revisions as needed

IV. Equipment expenditures:

- -coordinated purchasing procedure
- -control of funds

V. Implementation:

-coordination between technical plan and hardware installation
-interaction between installation group and planning group
-plan modification as hardware problems are encountered

VI. Evaluation of the system:

-have goals and objectives been met?
-modifications if necessary

APPENDIX F

STATE EMERGENCY RADIO FREQUENCIES

POLICY, PROCEDURE, RULES AND REGULATIONS

APPENDIX F

STATE OF MONTANA
DEPARTMENT OF ADMINISTRATION
COMMUNICATIONS DIVISION
STATE EMERGENCY RADIO FREQUENCIES
POLICY, PROCEDURE, RULES AND REGULATIONS

SUBJECT

Cooperative use of State emergency frequencies by Public Safety Agencies. (law enforcement, local government, fire, special emergency, and highway maintenance)

PURPOSE

To allow utilization of Montana emergency frequencies by Public Safety Agencies.

POLICY

The State of Montana will provide access by Public Safety Agencies on a controlled basis to the State emergency frequencies in accordance with standard procedures. Access will be provided to insure all public safety agencies have at their disposal, the full resources available to the State to protect the safety and/or property of the general citizenry.

ADMINISTRATION

State emergency frequencies are administered by the Communications Division, Department of Administration, located at the Sam W. Mitchell Building, Room 222, Helena, Montana, 59620. (406)449-2586.

I. PROCEDURE

Any Public Safety Agency desiring to utilize a frequency licensed to the State of Montana will be required to enter into a cooperative agreement with the State of Montana and provide the following documentation:

A. The Chairman of the County Commissioners, Chief Executive of a Municipality, County Sheriff, City Chief of Police, City or County Fire Chief, EMS Director or similar officer

of an agency desiring use of a frequency will send a request to the Communications Division Administrator containing the following information:

1. The requesting agency will certify that it meets all Federal and State eligibility requirements as specified by the Federal Communications Commission under Parts 90, Section 90.17(a), 90.19(a), 90.21(a) and 90.421(a), (b), (c), and Section II of this policy.

2. A complete list of the radios using State emergency frequency(ies). The list shall include:

   Mobiles - Type, model and serial number of the radio together with the type and license number of the vehicle in which it is installed.

   Hand Held Portables - Type, model and serial number of the radio together with the name of the agency or person to whom the radio is assigned.

3. The agency's assurance that these frequencies will be installed only in radios owned or exclusively controlled by the requesting agency and the equipment complies with all applicable Federal Communications Commission Rules and Regulations, Volume V, Part 90.

4. The requesting agency will provide its assurance that it will comply with all applicable F.C.C. rules, regulations, Volume V, Part 90 for the cooperative use of a State emergency frequency.

B. The State will provide each approved user with a cooperative agreement for use of the frequency(ies) in question. The cooperative agreement will be signed by the Communications Division Administrator and the authorized agent of the requesting agency.

C. All applications submitted in accordance with these policies will be processed within 30 days.

II. ELIGIBILITY

Requesting agencies must meet the appropriate

criteria for each frequency requested in order for their requests to be considered for approval.

A. Police Emergency Frequency -

1. The agency must be duly sworn and authorized to perform law enforcement duties as are established by State statutes and local ordinances with full police powers and responsibilities for protection of life and property in their jurisdictional area.

2. All law enforcement aencies requesting use of the police emergency frequency in mobile or portable radios must provide a written statement demonstrating eligibility and assuring full compliance under F.C.C. Rule Section 90.19(a) and 90.421 and State regulations pertaining to this Agreement.

B. Local Government Emergency Frequency -

1. The agency must be a county, city, town or similar political subdivision as established by State statutes. The Agency may submit applications on behalf of other entities providing public safety services within their jurisdiction (e.g. school bus contractors, search and rescue, wrecker service).

2. All applicants requesting use of the local government emergency frequency in mobile or portable radios must provide a written statement demonstrating eligibility under the applicable F.C.C. Rule Section, Part 90 and assuring full compliance with 90.421, and State regulations pertaining to this Agreement.

C. Fire Emergency Frequency -

1. The agency must be a county, city, town or similar political subdivision or persons or organizations charged with specific fire protection actities as established by State statutes and/or local ordinances.

2. All fire protection agencies requesting use of the fire emergency frequency in mobile and/or portable radios must provide a written statement demonstrat-

ing eligibility under F.C.C. Rule Section 90.21(a) and assuring full compliance with 90.421 and State regulations pertaining to this Agreement.

III. STATE RULES AND REGULATIONS

A. No section of this policy or its subsequent procedure should be construed to imply that the State has the authority to assign or license a frequency currently licensed to the State of Montana, nor should this procedure be interpreted as providing the State with any regulatory power over these frequencies, other than those specific control functions the State is obligated to accept as a licensee.

B. The following special functions will be allowed when using State emergency frequencies provided said functions are included as an integral part of the approved cooperative agreement or its noted appendices:

1. Emergency crosschannel patch through a dispatch control console previously approved by the Communications Division.

2. Emergency telephone patch through a device approved by the Communications Division.

C. All users must operate in total compliance with existing F.C.C. Rules and Regulations and State of Montana Rules, Regulations, Laws, and administrative policies. No exceptions can be tolerated.

D. All agencies will confiscate all crystals or frequency elements for the frequencies authorized under its cooperative agreement when a radio is phased out of service or is no longer in the control of the agency. Under no circumstance will crystals or frequency elements be left in a radio no longer under the agency's control. The agency will provide written notification (to include the radio type, model number and serial number) to the Communications Division within 30 days of the radio being phased out of service or no longer in the control of the agency.

E. If mobile radios or handheld portables authorized under cooperative agreements are transferred to a new vehicle, agency, or person, written notification of such transfer must be provided to the Communications Division by the cooperating agency within 3 months of the date of transfer.

F. All agencies installing new radios using State Emergency Frequency(ies) will notify and receive approval from the Communicatons Division prior to the radio being placed in service. The written notification shall include:

Mobiles - Type, model number and serial number of the radio together with the type and license number of the vehicle in which it is installed.

Hand Held Portables - Type, model number and serial number, of the radio together with the name of the agency or person to whom the radio is assigned.

G. Communications on State Emergency Frequency(ies) is limited to the following:

1. Emergency communications between public safety agencies from various jurisdictions.

2. Emergency or administrative communications by itinerant public safety vehicles when away from their normal jurisdiction.

3. Command and control communications by supervisory personnel in situations where public safety agencies from multiple jurisdictions are responding to an emergency.

4. Urgent administrative communications between public safety agencies where no other means of communication is readily available.

H. Enforcement of all rules established for State emergency frequency(ies) is essential if the frequency(ies) is to be effective. All agencies are encouraged to report violations of established rules to the Communications Division.

Reported violations will be reviewed by the Communications Division and a warning letter sent to the manager of the offending agency, outlining all pertinent details of the reported violation. The agency also will be advised that its cooperative agreement is subject to cancellation, as proper operation was one of the commitments made prior to obtaining permission to use the frequency. Warning letters will require a written reply to the Communications Division within 10 days of receipt, detailing what action the agency has taken to prevent future violations.

If an agency repeatedly violates the rules established for use of State Emergency Frequency(ies) its cooperative agreement will be cancelled.

I. Authorization covered under this policy can be immediately terminated upon verification of any infraction of the State or Federal Rules and Regulations with a copy of the coooperative agreement cancellation sent to the Federal Communications Commission Enforcement Division.

Upon written notification from the Communications Division terminating its authorization, the agency will cease all operations on State emergency frequency(ies) and remove the frequency elements from their radios.

EXCERPTS FROM F.C.C.
RULES AND REGULATIONS
VOLUME V, PART 90

§ 90.17 Local Government Radio Service.

(a) *Eligibility.* Any territory, possession, State, county, city, town, and similar governmental entity, including a district and an authority, but not including a school or park district or authority except as provided for in § 90.242 is eligible to hold authorizations in the Local Government Radio Service to operate radio stations for transmission of communications essential to official activities of the licensee.

§ 90.19 Police Radio Service.

(a) *Eligibility.* Any territory, possession, State, county, city, town, and similar governmental entity including a governmental institution authorized by law to provide its own police protection, is eligible to hold authorizations in the Police Radio Service to operate radio stations for transmission of communications essential to official police activities of the licensee.

§ 90.21 Fire Radio Service.

(a) *Eligibility.* Any territory, possession, state, county, city, town, or similar governmental entity, and persons or organizations charged with specific fire protection activities are eligible to hold authorizations in the Fire Radio Service to operate radio stations for transmission of communications essential to official fire activities of the licensee. Applications from persons or organizations other than governmental entities must be accompanied by a statement from the governmental entity having legal jurisdiction over the area to be served, supporting the request.

§ 90.37 Rescue organizations.

(a) *Eligibility.* Persons or organizations operating a rescue squad are eligible to hold authorizations to operate radio stations for transmission of messages pertaining to the safety of life or property and urgent messages necessary for the rendition of an efficient emergency rescue service.

(b) Class and number of stations available. Each rescue squad will normally be authorized to operate one base station, and a number of mobile units (excluding hand carried mobile units) not exceeding the number of vehicles actually used in emergency rescue operations. In addition, each rescue squad will be authorized to operate a number of hand carried mobile units not exceeding two such units for each radio equipped vehicle actually used in emergency rescue operations.

[*§ 90.37(b) corrected eff. 6-24-80; V(79)-2*]

§ 90.43 School buses.

(a) *Eligibility.* Persons or organizations operating school buses on a regular basis over regular routes are eligible to hold authorizations to operate radio stations for the transmission of messages pertaining to either the efficient operation of the school bus service or the safety or general welfare of the students they are engaged in transporting.

(b) *Class and number of stations available.* Each school bus operator may be authorized to operate one base station and a number of mobile units not in excess of the total of the number of buses and maintenance vehicles regularly engaged in the school bus operation. Additional base stations or mobile units will be authorized only in exceptional circumstances when the applicant can show a specific need.

[*§ 90.43(a) corrected eff. 6-24-80; V(79)-2*]

§ 90.403 General operating requirements.

(a) Licensees of radio stations in the private land mobile radio services shall be directly responsible for the proper operation and use of each transmitter for which they are licensed. In this connection, licensees shall exercise such direction and control as is necessary to assure that all authorized facilities are employed:

(1) Only for permissible purposes;

(2) Only in a permissible manner; and

(3) Only by persons with authority to use and operate such equipment.

(b) In carrying out their responsibilities under § 90.403(a), licensees shall be bound by the provisions of the Communications Act of 1934, as amended, and by the rules and regulations of the Commission governing the radio service in which their facilities are licensed; and licensees may not, through written or oral agreements or otherwise, relieve themselves of any duty or obligation imposed upon them, by law, as licensees.

(c) Each licensee shall restrict all transmissions to the minimum practicable transmission time and shall employ an efficient operating procedure designed to maximize the utilization of the spectrum.

(d) Communications involving the imminent safety-of-life or property are to be afforded priority by all licensees.

(e) Licensees shall take reasonable precautions to avoid causing harmful interference. This includes monitoring the transmitting frequency for communications in progress and such other measures as may be necessary to minimize the potential for causing interference.

(f) Stations licensed in this part shall not continuously radiate an unmodulated carrier except where required for tests as permitted in Section 90.405, except where specifically permitted by this part, where specifically authorized in the station authorization, or on an as needed basis in the Radiolocation Radio Service.

(g) The radiations of the transmitter shall be suspended immediately upon detection or notification of a deviation from the technical requirements of the station authorization and until such deviation is corrected. For transmissions concerning the imminent safety-of-life or property, the transmissions shall be suspended as soon as the emergency is terminated.

§ 90.405 Permissible communications.

Stations licensed under this part may transmit only the following types of communication:

(a) Any communication related directly to the imminent safety-of-life or property;

(b) Communications directly related and necessary to those activities which make the licensee eligible for the station license held under this part. In addition, when communication service is provided under the cooperative sharing provisions of § 90.179, the licensee providing such service may transmit communications related to the activities for which the parties receiving the service would be eligible to be licensed.

(c) Communications for testing purposes required for proper station and system maintenance. However, each licensee shall keep such tests to a minimum and shall employ every measure to avoid harmful interference.

§ 90.417 Interstation communication.

(a) Any station licensed under this part may communicate with any other station without restriction as to type, service, or licensee when the communications involved relate directly to the imminent safety-of-life or property.

§ 90.421 Operation of mobile units in vehicles not under the control of the licensee.

Mobile station transmitters may be installed in vehicles operated by persons other than the licensee as provided in the following paragraphs when necessary for the licensee to meet his requirements in connection with the activities for which he is licensed. The number of units so installed, together with units installed in vehicles operated by the licensee, must not exceed the number of mobile units authorized to the licensee. When an insufficient number of units is licensed to cover such additional units, the license must be modified to add a sufficient number of mobile units. The licensee is responsible for taking any necessary precaution to effectively eliminate the possibility of unauthorized operation of transmitters when not under the control of the licensee.

(a) Mobile units licensed in the Local Government Radio Service may be installed in any vehicle which in an emergency would require cooperation and coordination with the licensee, and in any vehicle used in the performance, under contract, of official activities of the licensee. This includes ambulances, emergency units of public utilities, lifeguard units, and vehicles of contractors or other persons or agencies performing for the licensee under contract one or more of its local government functions. This provision does not permit the installation of radio units in non-emergency vehicles not performing governmental functions under contract but with which the licensee might wish to communicate.

(b) Mobile units licensed in the Police Radio Services may be installed in any vehicle which in an emergency would require cooperation and coordination with the activities of the licensee. This includes emergency units of public utilities, lifeguard emergency units, ambulances, fire department vehicles and rural school buses.

(c) Mobile units licensed in the Fire Radio Service may be installed in emergency vehicles which may be alerted during a fire emergency. This includes emergency units of public utilities and water departments.

§ 90.425 Station identification.

Stations licensed under this Part shall transmit identification in accordance with the following provisions:

(a) *Identification procedure.* Except as provided in paragraph (d) of this section, each station or system shall be identified by the transmission of the assigned call sign during each transmission or exchange of transmissions, or once each 15 minutes (30 minutes in the Public Safety and Special Emergency Radio Services) during periods of continuous operation. The call sign shall be transmitted by voice in the English language, or by International Morse Code in accordance with paragraph (b) of this section. Permissible alternative identification procedures are as follows:

(1) A mobile relay station call sign may be used to identify the associated control and mobile stations, except in the Public Safety and Special Emergency Radio Services where the stations operate on frequencies below 470 MHz. Alternatively, a base station (including a mobile relay station) which is controlled by radio may be identified by the transmission of the call sign of the station at which communications originate.

(2) One or more fixed relay stations may be identified by the transmission of the call signs of the stations at which the communications originate.

(3) When a mobile station transmits on a different frequency than its associated base station, the assigned call sign of either the mobile station or the base station may be transmitted. Further, a single mobile unit in the licensee's authorized geographic area of operation may transmit station identification on behalf of any other operating mobile units in the fleet.

(4) *Use of an identifier other than the assigned call sign.* (i) In the Public Safety and Special Emergency Radio Services, mobile units licensed to a governmental entity and which operate on frequencies above 30 MHz may use an identifier which contains, at a minimum, the name of the licensee; *Provided*, That the licensee notifies, in writing, the Engineer-in-Charge of the field office area in which the units will operate, of the specific identifier(s) to be used by the mobile units.

§ 90.427 Precautions against unauthorized operation.

Each transmitter shall be so installed and protected that it is not accessible to or capable of operation by persons other than those duly authorized by and under the control of the licensee. Provisions of this part authorizing certain unlicensed persons to operate stations, or authorizing unattended operation of stations in certain circumstances, shall not be construed to change or diminish in any respect the responsibility of station licensees to maintain control over the stations licensed to them (including all transmitter units thereof), or for the proper functioning and operation of those stations and transmitter units in accordance with the terms of the licenses of those stations.

§ 90.433 Operator license requirements.

No operator license or permit is required for the operation of stations licensed under this part except as follows:

(a) *Maintenance and tests.* All transmitter adjustments or tests during the installation, servicing, or maintenance of a radio station which may affect the proper operation of such station shall be made by or under the immediate supervision and responsibility of a person holding a first- or second-class commercial radio operator license, either radiotelephone or radiotelegraph, who shall be responsible for the proper functioning of the station equipment.

APPENDIX G

OUTLINE

FOR

STATEWIDE PUBLIC SAFETY

FREQUENCY UTILIZATION PLAN

APPENDIX G

OUTLINE FOR STATEWIDE PUBLIC SAFETY FREQUENCY UTILIZATION PLAN

INTRODUCTION

The Federal Communications Commission (FCC) relies heavily on the recommendations of local frequency coordination. From each license applicant, the FCC requires a field study indicating the degree of probable interference with existing stations on the same channel within 75 miles of the proposed station and a signed statement that all existing co-channel licensees within 75 miles of the proposed station have been notified of the applicant's intention to file an application.

The main function of frequency utilization planning is to enable the allocation of frequencies on an orderly basis and make public safety radio communications a more valuable tool. A frequency utilization planning process would relieve the individual agency applying for licenses of the requirement that it make interference studies prior to being licensed on a particular frequency. Any agency may file a license application directly to the FCC, but must, then, undertake its own frequency study. The following are proposed elements of a statewide public safety utilization plan:

FREQUENCY PLAN OBJECTIVES

1. Equalize the loading on each public safety frequency.

2. Maximize geographic separation between systems sharing the same frequency.

3. Utilize all available frequencies.

FREQUENCY PLAN GUIDELINES

1. As many existing VHF high band frequencies as possible should be retained.

2. All applicable FCC rules and regulations should be adhered to and incorporated as an appendix to the plan.

3. Limitations should be established for Effective Radiated Power (ERP), identifying maximum desirable watts for omni-directional antenna systems.

4. Limitations should be established for maximum overall antenna height above the average mean sea level height

of the system's terrain.

5. Directional antennas should be used where necessary.

6. Any control tones used should be subaudible.

7. All systems should be equipped with tone-coded squelch.

8. Base stations should be equipped with a time-out timer.

9. Adjacent channel frequencies should not be used within 10 miles of each other, according to FCC rules and regulations. An exception would be the mutual aid frequencies for which a waiver would be asked, case by case.

10. The statewide mutual aid frequencies for local government, police and fire should be incorporated into the plan. These frequencies should be used for mutual aid situations only. A set of rules regarding how these channels are to be used should be incorporated into the plan.

11. Tone-coded squelch frequencies should be assigned to all systems on the basis of geographic location. The selection of these frequencies should be based on existing system tone use and tone assignments of other non-local users of the channel. The use of tone squelch greatly reduces co-channel interference problems.

12. The mobile frequencies should be allocated for mobile operation only. The plan should follow the basic FCC regulations for mobile frequency use.

APPENDIX H

STATEWIDE RADIO COMMUNICATION NETWORK

(SECURE)

APPENDIX H

STATEWIDE RADIO COMMUNICATION NETWORK
(SECURE)
MONTANA ARMY NATIONAL GUARD
DEPARTMENT OF MILITARY AFFAIRS

The creation of the DMA statewide radio communication network is brought about by combining three resources/assets into one combined concept.

First is the Disaster and Emergency Services Division "SECURE" communications system proposal.

BACKGROUND

In November 1981, FCC in a new ruling (FCC Docket 80-7) allocated portions of the High Frequency Radio Spectrum (2MHz - 10 MHz) to be used by states to establish long range communications. This HF Spectrum does not depend on relay points and is not line-of-sight, so it should permit long as well as short-range communications within the State and with adjacent states. The frequencies allocated are licensed to states and are for disaster uses only with the exception of a weekly test not to exceed sixty (60) minutes.

JUSTIFICATION:

The State of Montana has no statewide emergency radio capabilities. In times of emergency, we must depend on other overtaxed in-place State systems such as Montana Highway Patrol and Highway Maintenance. We also utilize the Radio Amateur Civilian Emergency Services (RACES). This capability is provided by volunteer licensed ham operators. This proposal would provide base sets in all large counties and high hazard (nuclear and natural) areas, and in addition, would provide mobile capabilities strategically located where full time employees are available to allow complete State coverage in short periods of time.

PROPOSED LOCATIONS:

Base Station Location	Nuclear Threat	Operational EOC
1. Helena	Risk/Host	Yes
2. Great Falls	Risk	No
3. Billings	Risk	No
4. Miles City		Yes
5. Missoula	Risk	Yes
6. Glasgow	Risk/Host	Yes
7. Kalispell	Host	Yes
8. Butte	Risk	Yes
9. Bozeman	Host	Yes

Second is the National Guard as a Military Organization. It has a requirement for a communication system not dependent upon land lines which is operable on a regular basis for emergency and routine communications. This system has been being built upon for several years until it reached its present inventory of thirteen (13) radios. This number falls short of meeting the needs of 25 locations where National Guard units are located. Seven (7) mobile units would allow improved remote location emergency communication.

Third is the Department of Military Affairs as a State Agency. It is faced with not enough money to adequately fund the remote units telephone expenses. At the present time fourteen (14) units do not have WATS line service and they are forced to make a substantial number of long distance phone calls daily. A majority of these calls are to other units of the National Guard and to the various Headquarters with the Montana Guard. If each unit had a radio set located in the armory then most of the calls to other units could be made by radio, reducing the long distance telephone costs.

When these three requirements were merged together we found that each could be satisfied by the purchase of sixteen (16) radios. We also were aware of Governor Schwinden's desire to have better communication with his Helena office and therefore decided to request his inclusion into the system.

The total requirement for equipment for the total program is as follows:

29 Radios positioned in 25 locations
7 Mobile units positioned in 5 locations

This would cover the State of Montana with a Radio Network as shown on the attached map.

This system would provide the following:

1. A non-land line communications system state wide in case of a disaster.

2. A non-land line communication system state wide for Military use in case of an emergency.

3. A non-land communication system for day-to-day use by the Department of Military Affairs.

4. A non-land line communication system for the Governor to use when travelling to remote locations.

5. A better communication system for the Adjutant General and his commanders who could communicate with all units at one time.

This proposed communication system is not intended for use by any other agency of State Government such as Law Enforcement or Highway Department. In an emergency these and other agencies could route traffic over this system, but not on a day-to-day basis.

The Montana National Guard has a requirement for a High Frequency (HF), Single Side Band (SSB) radio net in each of its unit locations. This communication net would be used on a daily basis for routine administrative traffic between the individual units and the several headquarters in the State. The use of the net in this manner will mean a substantial savings in long distance telephone bills at units which do not have the State telephone system available to them.

The system would also be an invaluable asset during a natural or man-caused disaster in which the National Guard is assigned to disaster recovery operations.

The Montana Guard already has thirteen (13) Base station HF SSB radios 7 of which are currently operation. Six (6) antennas are in a state of total deterioration and require reinstallation. The existing radios are located in Helena, Bozeman, Billings, Miles City, Culbertson, Dillon and Chinook. The other six (6) were/are located at Lewistown, Kalispell, Missoula, Glasgow, Malta and a spare in Helena. These radios operate in the frequency spectrum of 3-30 MHz with a power of up to 2000 watts PEP USB or LSB.

The Guard has no radio capability at the following unit locations (15): Great Falls, Plentywood, Sidney, Glendive, Havre, Harlowton, Livingston, Butte, Anaconda, Deer Lodge, Hamilton, Whitefish, Libby, Shelby, Belgrade.

Expanding the Guard's system has already been proposed and justified as mentioned above.

The FCC has recently allocated frequencies to the states for emergency communications "State Emergency Capability Using Radio Effectively (SECURE)" in the frequency range of 2-10 MHz and SSB emission.

The major drawback of the SECURE is that the frequencies can only be used during an actual emergency and for periodic testing of the radios.

The high cost of the radio equipment and associated antennas etc., make the SECURE system extremely difficult to justify for such a limited use system. Currently available systems such as Amateur Radio (RACES) would probably be as good or better.

However, when adding SECURE into the Guard's net and expanding the number of radios to each unit location it takes on a totally different character.

1. The Guard currently has 16 frequencies assigned for its use from 2-10 MHz, (the band for SECURE). These are authorized for use on a daily 24 hours basis.

2. The Guard's current radios are compatible with SECURE frequencies in the 3-10 MHz range. These SECURE frequencies would be available during emergencies in addition to those that the Guard already has.

3. Disaster and Emergency Services (DES) is a division of the Department of Military Affairs. Therefore, DES would be authorized to participate in the NG net on a daily basis for routine communications. Local DES coordinators at the City/County level could participate in the system if their local government provided the radio equipment. They could use the equipment in case of an emergency in any event, and the total NG system would be available.

CONCEPT OF OPERATION:

The thirteen (13) Guard radios, which are able to operate at 2000 watts of power will be, or are, located in strategic unit locations throughout the State.

The 16 new radios (SECURE equipment) would be positioned throughout the remainder of the units in the State.

DES could have two (2) radios on hand to dispatch to remote disaster sites where a NG radio is not readily available.

The Governor could have a radio for mobile operation throughout the State in his vehicle. This would permit him access to the complete NG system. For example:

1. The Governor is travelling somewhere in the State, i.e. Circle-Jordan area, and his office in Helena must contact him. He has a radio in his vehicle.

2. His office contacts the NG hdqtrs in Helena who immediately puts out the radio call. Contact is made and if it is of phone patch quality the office is in direct voice contact with the Governor. If it is not phone patch quality the message is then relayed by the radio operator.

3. Contact is not made by State Hdqtrs for some reason. So we would in turn direct another unit to attempt contacting the Governor's vehicle. In this case, possibly Miles City. Contact is made and if it is of phone patch quality a patch could be set up; otherwise messages could be relayed. If the unit that makes initial contact does not have phone patch capability then messages are relayed over the radio.

The above scenario is a normal work day. Nighttime operation

will be limited by:

1. Lack of personnel at unit armories.

2. Radio wave propagation at night is different than daylight hours which necessitates the use of different frequencies and antennas. For example, communication from Helena to Jordan at 1000 hours (10:00 A.M.) could be accomplished on a frequency between 7.6 - 8.1 MHz. At 2100 hours (9:00 P.M.) frequencies between 3.5 - 5.0 MHz would be used.

However, in disaster or emergency conditions the Guard armory radio could be manned on a 24 hour basis which would solve the problem posed in 1. above.

In some Guard locations it may be possible to locate the local DES coordinator at the armory if the local coordinator does not have adequate office space. But in any event, an antenna could be installed at the local EOC and when and if needed the radio could be relocated to operate from the EOC.

APPENDIX I

GLOSSARY

GLOSSARY

Access charge — Rental charge for an access line. Charge for accessing the telephone company network for local and/or long distance service.

Access code — The digit, or digits, a user must dial to be connected to an outgoing group of telephone lines. For example, Montana State Telephone System users dial "9" for a local line, "151" for an intrastate WATS line, "121" for a line to Billings, etc.

Access line — A circuit (e.g., telephone line) which connects a subscriber (customer) premises communications device (telephone, key system and/or PBX system) with a telephone company central office for the purpose of access to the telephone company's exchange and long distance networks.

Alternate routing — An alternative communications path used if the normal one is not available. A feature that gives the switching system the responsibility through a computerized package to select the most economical circuit to use on outgoing calls initiated by stations. This feature enables considerable economies to be realized because direct, high-usage circuit groups are used extremely efficiently and overflow routes are shared by several different sources of traffic.

Analog — In transmission, the term is used in opposition to digital. An analog signal is a nominally continuous electrical or electromagnetic signal that varies in amplitude or frequency in response to changes of sound, light, heat, position or pressure impressed on a transmission device (phone line). Analog transmission uses amplifiers (required due to weakening of the transmitted signal with distance) that magnify the incoming signal, including any noise components. Most voice signals on telephone lines are analog. (Compare to digital.)

Bandwidth — The range of frequencies that can pass through a circuit. The differences expressed in cycles per second (Hertz) between the highest and lowest frequencies of a band. For example, the radio frequency bandwidth of high band land mobile radios is 270 million cycles per second (270 MegaHertz).

Base station — A station in a land mobile radio system which remains in a fixed location and communicates primarily with mobile radios. A base station may secondarily

communicate with other base stations in the system.

Baud — A unit of data transmitting speed. The speed in baud represents the number of discrete signal elements transmitted in one second. Baud may or may not be the same as bits per second but is often used synonymously with bits per second.

Bit — Smallest unit of information used in data processing. It is a contraction of binary digit.

Broadband — Communication channel having a bandwidth greater than a voice-grade channel, and therefore capable of higher-speed data transmission or the ability to carry several voice channels. The bandwidth is greater than 20,000 Hertz (cycles per second).

Byte — A group of eight bits makes a byte. Usually the smallest addressable unit of information in data storage or memory.

Carrier — A continuous frequency capable of being altered or modulated and/or impressed with a second signal or frequency to carry information.

Carrier, Common — A private company which furnishes communications services to the general public as well as the government and business sectors, and which is regulated by appropriate local, state or federal agencies. The local telephone company is a common carrier.

Central Office — Common carrier facility where customer lines are terminated and joined to switching equipment for connecting other subscribers to each other, locally and long distance.

Centrex — Service provided by Bell which makes customer's phones part of the Central Office. Equipment may be located on the customer's premises (Centrex CU) or, more commonly, at the telephone company's Central Office (Centrex CO). It allows calls to be dialed directly to individual phones in the system without operator assistance (bypasses the operator).

Channel — A means of one-way transmission, either electrical or electromagnetic (radio waves). As used in the tariffs, a path for transmission between two or more points without common-carrier-provided terminal equipment. A radio channel utilizing a specific frequency for either transmitting or receiving a radio signal or both.

Channel, Data-grade — A channel suitable for transmitting data or facsimile but not usually suitable for voice transmission.

Channel, Voice-grade A channel suitable for transmission of voice, digital or analog data, or facsimile, generally with a frequency range of about 300 to 3400 cycles per second (Hertz).

Channel termination Refers to physical connection of a transmission channel (line) to terminal equipment at each end of the channel.

Circuit A means of two-way communications between two points. The physical connection (e.g., telephone line) using terminal equipment of two channels between two points. Includes both sending and receiving capabilities.

Circuit, Four-wire A circuit which uses separate paths for the two directions of transmission (two wires for send and two wires for receive).

Circuit, Two-wire A circuit in which information signals in both directions are carried by the same two-wire path.

Co-channel interference See interference.

Control station A station in a land mobile radio system which is used to control the output of a base station (usually a remote base station). Control stations commonly remain in a fixed location.

CPE Customer Premises Equipment. Terminal equipment located on the customer's premises such as telephones, key systems and/or PBX systems, supplied by either the telephone common carriers or by a competitive supplier, which is connected to the telephone company network.

Crossbar switch A telephone switch having a plurality of vertical paths, a plurality of horizontal paths, and electromagnetically operated mechanical means for interconnecting any one of the vertical paths with any of the horizontal paths. The State's central switch, located in Helena at Bell's Central Office, is a crossbar switch.

Crystal The frequency element in a land mobile radio unit. The element is usually made of quartz and is factory-tuned to a specific desired transmit or receive frequency.

Cutover The physical changing of lines from one system to another, or the installation of a new system. A flash cut is done instantly while in a parallel cut, two phone systems (the old and the new) operate side by side ensuring the new is operating well when it is time to "cut over".

Data set A device that converts the signals of a business

machine to signals that are suitable for transmission over telecommunications circuits and vice-versa. The device performs the modulation/demodulation and control functions necessary to provide compatibility between business machines and communications facilities. The Bell System name for modem.

DDD An abbreviation for Direct Distance Dialing, which means making long distance telephone calls without operator assistance. DDD is normally used in data communications to mean the switched telephone network. DDD is part of the general category of toll calls.

Dedicated channel or circuit A channel leased from a common carrier by a customer (end user) which is used exclusively by that end user. Also called a private line or leased line.

Dial-up The use of a dial or pushbutton telephone to initiate a station-to-station telephone call or data transmission.

Digital A discrete or discontinuous signal; one whose various states are discrete signals in transmission; not a continuously variable analog type of transmission. Digital transmission uses repeaters that generate completely new signals, thus minimizing noise transmission. Digital signals must be transformed through a modem to be carried over analog transmission links and vice-versa. Data signals are always digital before being transmitted from point to point. (Compare with analog.)

Duplexer Device utilizing tuned filters (filter out all but desired frequencies) which permits transmitter and receiver to operate on the same antenna.

Duplex transmission Simultaneous two-way independent transmission in both directions (send and receive). Also called full-duplex transmission. (Compare with half-duplex transmission.)

Electronic mail A term which refers to services or systems that transmit written information between two or more terminals via telecommunications links (phone lines, data lines, etc.).

End charge Monthly rental charge to customers by a common carrier for the equipment required to provide connection between transmission lines (channels) and local facilities (telephone company Central Office). End charges are paid for equipment at each end of the transmission channel and vary according to the grade of transmission channel (data-grade, voice-grade, etc.).

ESS Abbreviation for Electronic Switching System. A telephone switching system which uses electronic or computer-like devices to control the circuit switching and other functions.

Exchange A unit established by a communications common carrier for the administration of communication service in a specified area which usually embraces a city, or town and its surrounding area. It consists of one or more central offices together with the associated equipment used in furnishing communication service. Often referred to as the local exchange area.

Exchange, Trunk An exchange devoted primarily to interconnecting trunks.

Facsimile (FAX) A telecommunications system for the transmission of images. The image is scanned at the transmitter, converted into an electrical signal, transmitted over some communications link (e.g., telephone line), reconstructed at the receiving station, and duplicated on some form of paper.

FCC Abbreviation for Federal Communications Commission. A board of five commissioners appointed by the President under the Communication Act of 1934, having the power to regulate all interstate and foreign electrical and electromagnetic communication systems originating in the U.S.

Fiber optics A medium for transmitting information in cable form by directing photons (tiny packages of light) of light through a glass fiber, or optical waveguide, which is a fine strand of ultra-pure glass weighing on the order of one ounce per kilometer and as thin as a human hair.

Foreign exchange service (FX) A communication line connection which provides local telephone service from a central office which is outside (foreign to) a subscriber's exchange area. In its most usual form, a user dials one or two digits and receives dial tone in a distant city. Once the user receives that dial tone a local or long distance call can be made. An FX line is typically used when many long distance calls are made to and/or from a distant city and long distance charges for those calls are to be minimized.

Frequency A measure of how frequently a periodic (repetitious) wave form or signal repeats itself in a given unit of time. Most common measure of frequency is cycles per second (Hertz). Frequencies are typically grouped into ranges such as AM radio (540 KHz to 1650 KHz), FM radio (88 MHz to 109 MHz), and so on.

Frequency spectrum Division of electromagnetic radiation frequencies according to characteristics and use, e.g., radio spectrum, visible light spectrum, audio spectrum, infrared spectrum, etc.

Grade of service A term associated with local exchange service, indicating the probability that a call will be blocked by a busy signal. A P.01 Grade of Service means the user has a 1% chance of reaching a busy signal, P.05 means 5%, and so on.

Half-duplex (HD or HDX) A circuit designed for transmission alternately in either direction but not both directions simultaneously. (Compare with duplex.)

Hertz (Hz) A measure of frequency or bandwidth. The same as cycles per second.

High-speed data transmission Transmission over data communications lines at a data speed of 2400 baud or greater. 4800 and 9600 baud lines are commonly referred to as high-speed data lines.

High band frequency Refers to those radio frequencies in a portion of the very high frequency (VHF) spectrum (30 to 300 MHz). Common high band frequency range in land mobile radio systems is 150.775 to 173.375 MHz.

Interconnect A situation where a customer-provided piece of telephone equipment is connected to, or has access to, the public switched telephone network provided by a common carrier. It also refers to the entire industry of manufacturers and distributors (those other than the local telephone company) who supply equipment directly to customers.

Interexchange channels (IXC) Channels making up circuits traversing more than one exchange area. Rates for these channels in the State of Montana are about three times higher than rates for TELPAK channels.

Interference In a signal transmission system, extraneous power from natural or man-made sources that interferes with reception of desired signals. Two common types of interference in land mobile radio communications are co-channel interference (resulting from two or more transmissions in the same radio channel or on the same frequency) and adjacent channel interference (caused by a transmitter operating on an adjacent frequency).

Interoffice trunk A direct trunk between local central offices.

Intertoll trunk A trunk between toll offices in different telephone exchange areas.

Key system A telephone sytem in which the telephones have multiple buttons permitting the user to select outgoing or incoming central office phone lines. A key system is characterized by the fact it is not necessary to dial "9" to obtain a central office line. All users may obtain access to lines on the public network and may communicate with each other without needing the services of an operator.

Leased line A communication channel leased from a common carrier for exclusive use in transmitting voice or data. Frequently referred to as a dedicated line or private line. (Also leased channel or leased circuit.)

Least cost routing See alternate routing.

Line A device for transferring electrical energy from one point to another, such as transmission line. Line communication is telecommunications using a physical means such as wire, cable or optical fiber to carry the signal. An electrical path between a telephone company central office and a subscriber (user), usually with an individual phone number that can be used for incoming and outgoing calls. Can also refer to an electrical path that connects central offices in different communities.

Line capacity Information or signal carrying capacity of a transmission line.

Line charge Rental charge for a dedicated line.

Local exchange See exchange.

Long Lines AT&T Long Lines Division. The division of AT&T which operates and manages all interstate long distance toll service in the Bell System.

Low band frequency Refers to those radio frequencies in the lower portion of the very high frequency (VHF) spectrum (30 to 300 MHz). Common low band frequency range in land mobile radio is 25.02 to 49.58 MHz. (Compare to high band frequency.)

Low speed data transmission Transmission over data communications lines at data speeds less than 2400 baud. A common low speed for data transmission is 300 baud. (Compare to high-speed data transmission.)

Main station line Line used to connect a telephone instrument having its own unique number to a central office. (See station, main.)

Measured service Also known as Usage Sensitive Pricing. A

method of pricing local telephone service based on the number of calls. Measured service charges are often based on the number of calls, the time of day the call is made, the length of each call and the distance of the call. Montana intrastate WATS will be a measured service based on total duration of calls per month effective February 1, 1983.

Microwave — Any electromagnetic wave in the radio frequency spectrum between 1,000 and 300,000 MHz. A technology used as a transmission system alternative to hard-wire transmission means such as wire, cable or fiber. Can be digital or analog.

Modem — An acronym for MOdulator/DEModulator. Equipment which converts digital signals to analog signals and vice-versa. Modems are used to send data signals (digital) over the telephone company network which is analog.

Modulation — Impressment of information on a carrier signal by varying one or more of the carrier's three basic characteristics: frequency, amplitude and phase. A controlled variation with time of any property of a wave (carrier signal) for the purpose of transferring information. This technique is used in data sets and modems to make business machine signals compatible with communications facilities.

Multiplex (MUX) — Use of a common channel to make two or more channels. This is usually done either by splitting of the common channel frequency band into narrower bands, each of which is used to constitute a distinct channel (frequency division multiplex); or by alloting this common channel to multiple users in turn, to constitute different intermittent channels (time division multiplex).

Multiplexer — Electronic equipment which allows two or more signals to pass over one transmission line. A device that multiplexes. In data communications, a device that allows handling of multiple low speed signals over a single high speed channel.

Off-premise extension (OPX) — A PBX extension located in a building other than the one housing the PBX itself. A telephone located on premises other than where the main phone system is. The distant phone acts as if it were in the same place as the main phone system. Also called off-premise station.

Other common carrier (OCC) — Provider of long distance phone service (intrastate or interstate) other than and in competition with AT&T.

PBX (Private branch exchange) — A manual exchange connected to

the public telephone network on the user's premises and operated by an attendant usually supplied by the user. A private phone system allowing communications within a business and between the business and the outside world. In the past, a PBX was a manual phone system in which calls were made by an operator inserting plugs into jacks. Modern PBXs are automated and called PABXs (Private automated branch exchanges). Sometimes they're called CBXs for computerized branch exchanges. A PBX differs from a key system in one primary respect: to make an outgoing call on a PBX, a user must dial "9" while on a key system, a user can typically access an outside line by simply pushing a button on the phone and getting a dial tone. There are hybrid systems (key and PBX systems) that combine the features of both.

Private line — A point-to-point telephone line for the private use of one subscriber. Denotes the channel and channel equipment furnished to a customer as a unit for that customer's exclusive use, without interexchange switching arrangements. Sometimes referred to as a dedicated line.

Repeater — A device whereby signals received over one circuit are automatically repeated in another circuit or circuits, generally in an amplified and/or reshaped form. In transmission systems, a device used to restore signals, which have been distorted or weakened due to distance of transmission, to their original state and transmission level. Active repeaters (those common in digital systems) regenerate, amplify and retransmit the received transmission signal. Passive repeaters (common in analog systems) simply relay the signal in a manner similar to a simple reflection of a beam of light.

RF (Radio Frequency) — Roughly the range of frequencies from 10 KHz (10,000 cycles per second) to 100 gigaHertz (100 billion cycles per second). A frequency suitable for communications purposes.

Simplex — Denotes operation of a communication channel in one direction only, with no capability for reversing. A simplex circuit permits transmission in one specific direction only.

Skip interference — Radio frequency interference common in low band land mobile radio systems. Can be greatly minimized by use of high band radio equipment. An interference phenomenon caused by refraction of radio waves back to the earth from the ionospere.

Spectrum — A continuous range of frequencies within which waves have some specific common characteristics. Examples are voice spectrum, audio spectrum and radio spectrum.

Station — One of the input or output points of a communications system. For example, the telephone in the phone system or the point where the business machine interfaces with a transmission channel on a communications line.

Station, extension — Telephone instrument or set connected to the same main line as a main station. It is reached by dialing the number of the main station.

Station, main — Telephone instrument or set connected directly to a central office and having its own unique telephone number. For example, an office may have three unique phone numbers (lines) accessible on five telephones in the office. Three of these phones (one for each line) would be considered main stations and two would be extension stations.

Subscriber — A person, company or government entity who has telephone service provided by a telephone company. In other industries subscribers are commonly called customers.

Switch — A mechanical or solid state device which opens or closes circuits. In telephone systems, switches select transmission paths or circuits. A switching center is a location where an incoming call/message is automatically or manually directed (switched) to one or more outgoing circuits. A PBX is an example of a telephone switch.

Switched line — A telephone or data line that is connected to the switched telephone/data network. Any line connected directly into a switching center.

Switched network — A multipoint network with circuit switching (line selecting) capabilities. The telephone network is a switched network.

Tandem — The connection of the output terminals of one network, circuit or line directly to the input terminals of another so that one system is hooked up directly in front of or behind the other.

Tandem switch — An installation in a communications system in which telephone switching equipment connects trunks directly to trunks, but does not connect local customer loops (lines). Primarily switches traffic between central offices.

Tariff — Document filed by a communications common carrier (typically the telephone company) with a state public utilities commission (Montana Public Service Commission) or the F.C.C. which defines service offered, establishes rates customers will pay, and states the

general obligations of the common carrier and the customer. The F.C.C. or public utility commission has the regulatory authority to approve or disapprove tariff filings. An approved tariff becomes a contract between customers and the common carrier.

Telco — The local telephone company.

Teleconference — A conference between persons at different locations using a device or devices that permits the conference to be held over the phone lines.

Telpak — A Bell System bulk private line service that gives large users substantial savings over standard private line rates. A tariff filing that provides different groupings of channels at different rates per air mile.

Terminal — Any device capable of sending and/or receiving information over a communications channel. In data processing applications, a device equipped with a keyboard (like a typewriter keyboard) and an output device (display screen or printer) that is connected to a computer system for the input and/or output of data. In telephone systems, the point at which a telephone line ends, or is connected to other circuits of the network. A terminal may be as simple as a telephone or as complex as a small computer.

Terminal equipment — Communications hardware (equipment) at either end of a circuit. Terminal equipment includes telephones, key systems and PBXs.

Tie line — A trunk between PBXs. A private-line communications channel of the type provided by common carriers for linking (tying) two or more points (communities) together. Over tie lines, a normal seven digit phone number is not required to access one point from another. Three digit access codes are used in the State of Montana to provide communications capabilities over the State tie lines.

Toll call — Call to a point outside the local service area. DDD, credit card calls and collect calls are examples of toll calls.

Traffic — Messages/voice and data transmissions sent and received. The engineering of circuit quantities and switching and routing patterns to maximize efficiency.

Trunk — A major link in a communications system. A circuit connecting two exchanges in different localities. The connection is usually between two telephone switching centers.

Trunk group — The arrangement of similar types of trunk

circuits into an identifiable group. WATS lines can often be found arranged in trunk groups.

WATS (Wide Area Telephone Service) A service provided by telephone companies in the U.S. which permits a customer by use of an access line to make calls to telephones in a specific zone on a dial basis for a reduced usage-based charge. WATS rates are usually less than DDD rates. One prefix gives the user access to a large geographic area that may contain many prefixes. The three types of WATS used by Montana State government are intrastate ("151"), interstate ("171"), and incoming WATS ("800" service).

Wideband channel A channel with greater bandwidth than a voice-grade channel. Can carry more than one voice channel. See broadband.

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